

Special Article

Enhanced Recovery and Surgical Optimization Protocol for Minimally Invasive Gynecologic Surgery: An AAGL White Paper

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ABSTRACT This is the first Enhanced Recovery After Surgery (ERAS) guideline dedicated to standardizing and optimizing perioperative care for women undergoing minimally invasive gynecologic surgery. The guideline was rigorously formulated by an American Association of Gynecologic Laparoscopists Task Force of US and Canadian gynecologic surgeons with special interest and experience in adapting ERAS practices for patients requiring minimally invasive gynecologic surgery. It builds on the 2016 ERAS Society recommendations for perioperative care in gynecologic/oncologic surgery by serving as a more comprehensive reference for minimally invasive endoscopic and vaginal surgery for both benign and malignant gynecologic conditions. For example, the section on preoperative optimization provides more specific recommendations derived from the ambulatory surgery and anesthesia literature for the management of anemia, hyperglycemia, and obstructive sleep apnea. Recommendations pertaining to multimodal analgesia account for the recent Food and Drug Administration warnings about respiratory depression from gabapentinoids. The guideline focuses on workflows important to high-value care in minimally invasive surgery, such as same-day discharge, and tackles controversial issues in minimally invasive surgery, such as thromboprophylaxis. In these ways, the guideline supports the American Association of Gynecologic Laparoscopists and our collective mission to elevate the quality and safety of healthcare for women through excellence in clinical practice. *Journal of Minimally Invasive Gynecology* (2020) 00, 1–25. © 2020 AAGL. All rights reserved.

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Minimally invasive gynecologic surgery (MIGS) is a standard approach for the treatment of many benign and malignant gynecologic conditions [1]. Compared with surgery through laparotomy, perioperative outcomes for patients are considerably better with MIGS, including less pain and narcotic use, fewer complications (e.g., surgical site infection [SSI] and venous thromboembolism [VTE]), and shorter recovery [2–4]. In these ways, MIGS fulfills the Triple Aim objectives set forth by the Centers for

Medicare & Medicaid Services: higher quality surgical care delivered by achieving better surgical outcomes, lower health-related costs, and improved patient experience. We can further advance this by synthesizing and practicing according to an enhanced recovery after surgery (ERAS) pathway specific to the population consisting of patients requiring MIGS. ERAS pathways are a compilation of evidence-based, best practice guidelines applied across the perioperative period to mitigate the physiologic stress response to surgery and promote recovery. Key ERAS components for patients requiring MIGS include (1) preoperative patient education and optimization; (2) multimodal and narcotic-sparing analgesia; (3) nausea, SSI, and VTE prophylaxis; (4) maintenance of euvoolemia; and (5) liberalization of activity. At the 2018 annual American Association of Gynecologic Laparoscopists (AAGL) meeting, only one-third of the survey respondents attending the inaugural

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Enhanced Recovery After Minimally Invasive Surgery (MIS) panel session reported using a formal ERAS pathway for their patients requiring MIGS. This was, in part, owing to the inexistence of ERAS guidelines dedicated to MIGS. In response to this, the AAGL leadership assembled a task force of clinical experts on ERAS subject matter from diverse practice settings to formalize ERAS guidelines for MIGS.

Methods

The following consensus guidelines were generated by the AAGL ERAS Task Force on the basis of an extensive review and critical appraisal of the literature in the fields of anesthesia, general surgery, surgical nursing, and gynecology. An Embase and PubMed database search of publications was performed. The relevant publications were evaluated by the task force, with emphasis on meta-analyses, randomized controlled trials, and prospective cohort studies. The quality of evidence and recommendations were evaluated according to the Grading of Recommendations, Assessment, Development and Evaluation system. Strong recommendations indicate that the panel is confident that the desirable effects of an intervention clearly outweigh the undesirable effects, or vice versa. Weak recommendations indicate less certainty about the balance between desirable and undesirable effects. The recommendations, summarized in [Table 1](#), are based on the quality of evidence (high, moderate, low, and very low) and on the balance between desirable and undesirable effects [5].

Results

Preoperative Education and Counseling

Patient and provider engagement, education, and communication are fundamentally important. They form the basis of high-quality and safe care delivery. Patient participation in ERAS education is associated with improved clinical outcomes [6]. Practically speaking, effective preoperative counseling is likely the most surefire method to reduce postoperative call volume and unscheduled visit rates. Patients and their caregivers need to receive clear instruction about how to best prepare for surgery and recovery. Patient education should address the importance and process of preoperative optimization, hydration/carbohydrate (CHO) loading, and SSI/VTE prevention. It should demystify day-of-surgery activities and the procedure itself, as well as set realistic postoperative pain and functional goals. The instructions should also set expectations for a normal recovery course, describe common deviations from this, and recommend appropriate intervention(s). For example, many patients misinterpret constipation as a complication of surgery. This can be avoided by advising patients about the typical timing of the return of bowel function and the safe use of over-the-counter medications to treat routine postoperative constipation.

Because most patient-initiated telephone calls after MIGS are related to questions about constipation, pain, urinary catheters, and vaginal bleeding [7], the postoperative instructions should explicitly cover these topics. Activity restrictions should be reformulated as activity recommendations. The literature suggests that commonly restricted activities have no greater impact on intra-abdominal pressure than normal, unavoidable everyday activities. For example, increases in intra-abdominal pressure incurred by lifting a 13-pound load from the floor and by rising from a standard height chair (a common activity) are comparable [8]. Patients should be advised that walking and climbing stairs is immediately permissible, and that they can resume high-impact aerobic exercise, lifting, and sit-ups as soon as they feel capable. A 6-week minimum period of pelvic rest is recommended on the basis of expert opinion from the task force. Interestingly, accumulating data suggest that the provision of liberal postoperative-activity recommendations may result in improved pelvic floor outcomes among women who underwent MIGS [9]. Discharge planning should begin preoperatively by counseling patients and their caregivers about criteria as opposed to time-based readiness for discharge. This is key to maximizing the uptake of same-day discharge (SDD). It is advisable to avoid offering the option of overnight stay to patients who are SDD-eligible.

People typically have a difficult time remembering more than 3 to 5 main points when presented with new information. In addition, it is critical to recognize that population health literacy levels are generally low [10]. Thus, all verbal instructions should be reinforced with printed education materials targeting an eighth-grade reading level. Patients requiring surgery who have low health literacy levels typically need extra time and resources before discharge for the reiteration of information and instructions, as well as for managing concerns or anxiety regarding self-care [11]. Patient-facing printed materials that use graphical formats incorporating checklists and video teaching tools are most user-friendly. Designated nurses or surgical schedulers versed in ERAS can be helpful in reinforcing important elements of written education materials and in aligning patient expectations with their anticipated perioperative experience. One-on-one teaching as well as group sessions in structured “gynecology school” on the ERAS pathway (with audiovisual materials and question-and-answer sessions) have been described. In addition, in a recent study, with the addition of a formal ERAS teaching session and a newly hired “enhanced recovery” nurse, the ERAS protocol was associated with cost savings of approximately 10% [12,13].

Patients who have a working knowledge of how and when to get in touch with their team before and after surgery are less anxious. Ideally, a team member should contact the patient the day before surgery to resolve unanswered questions and review key tasks such as discontinuing medications, CHO loading, and skin prepping. Patients should also receive a call the day after discharge to inquire about their status and address any questions/concerns. This is particularly valued by patients who are SDD-eligible. The core

Table 1

Guidelines for perioperative care in MIGS: American Association of Gynecologic Laparoscopists Enhanced Recovery After Surgery Task Force recommendations

Component	Summary recommendation	Level of evidence	Recommendation grade
Preoperative education and counseling	This should engage patients in interventions to mitigate modifiable risks, set appropriate expectations for recovery, initiate discharge planning, and provide reassurance through repetition and frequent contact (Table 2).	Moderate	Strong
Preoperative optimization: Anemia	Target Hgb ≥ 12 g/dL for elective MIGS through pharmacotherapy to treat and prevent blood-loss anemia (Table 3).	High	Strong
Preoperative optimization: Hyperglycemia	Postpone elective MIGS for HbA1c $\geq 8.5\%$ to 9% . Omit routine serum glucose monitoring in nondiabetics; target serum glucose to <180 mg/dL in diabetics. DMII is not a contraindication to preoperative carbohydrate loading.	Moderate	Strong
Preoperative optimization: smoking and alcohol	Set a 4-week goal for discontinuing smoking and alcohol consumption; 6 weeks for heavy alcohol consumption.	High	Strong
Preoperative optimization: OSA	Screen for OSA. Advise sleep study for screen-positive patients and CPAP when sleeping ≥ 4 wk pre- and postop for patients with new/known OSA. For patients with suspected/known OSA, carefully consider safety of SDD and limit narcotics and IVF.	Moderate	Strong
Preoperative fasting and carbohydrate loading	Allow clear liquids, ideally approximately 50-gm CHO-rich beverage, up to 2 hours and low-fat solid food up to 6 hours before induction of anesthesia.	Moderate	Strong
PONV prophylaxis	Most MIGS patients have >3 risk factors for PONV and should receive dexamethasone in preop, ondansetron at case end, and be considered for scopolamine transdermal patch. Prophylaxis should include clear liquids up to 2 hours before procedure, limiting narcotics and avoiding volatile anesthetics and nitrous oxide.	High	Strong
Preoperative analgesia	Preoperative administration of nonopioid adjuncts (oral NSAIDs, acetaminophen, and dexamethasone) is synergistic and translates into opioid-sparing effects postoperatively. The urogesic phenazopyridine may increase voiding trial success. On the basis of current data, the risk of introducing gabapentinoids outweighs benefit.	High	Strong
Intraoperative analgesia	Limit narcotics, and avoid volatile anesthetics and nitrous oxide. There are no data supporting the routine use of ketamine, IV lidocaine, and regional blocks. Consider ketorolac (15 mg IV) 30 minutes before case end and port-site infiltration with local anesthetics.	Moderate	Strong
Postoperative analgesia: Narcotic naive patients	Prescribe ≤ 15 oxycodone 5-mg equivalents and an alternating schedule of NSAID and acetaminophen, unless hepatic or renal contraindications exist.	High	Strong
Postoperative analgesia: Narcotic tolerant patients	Patients who take morning maintenance opioids and gabapentinoids should take them the morning of surgery. Consider involving a pain medicine specialist; individualize the use of intraoperative analgesic adjuncts with anesthesia providers. Ensure equal opportunity to benefit from other ERAS interventions.	High	Strong
Pneumoperitoneum	There are no data supporting use of low-pressure pneumoperitoneum compared with standard pressure (12 mmHg–16 mmHg) or heated gas insufflation, with or without humidification, compared with cold gas in MIGS.	Moderate	Strong
IVF goals	Aim for euvolemia with intraoperative buffered, isotonic crystalloids at a rate of 1 mL/kg/hr to 3 mL/kg/hr. Do not administer IVF in preop; discontinue IVF at case end.	High	Strong
Infection prophylaxis	Implement an SSI prevention bundle for MIGS as outlined in Table 5. Only use β -lactam alternatives for patients with a history of IgE-mediated PCN hypersensitivity.	High	Strong
VTE prophylaxis	Prescribe perioperative VTE prophylaxis using a modified Caprini scoring system and revised thresholds for extended VTE prophylaxis in cancer cases. Using this approach, hormonal therapy need not be discontinued preop. Consider preop assessment for DVT in high-risk leiomyoma cases (uterine size ≥ 20 wk, iron-deficiency anemia, thrombocytosis, lower extremity edema and/or hydronephrosis).	Moderate	Strong
Surgical menopause prophylaxis	Offer women who are premenopausal a transdermal preparation of hormone replacement therapy after bilateral oophorectomy on DC home.	Low	Strong
Constipation prophylaxis	Senokot 8.6 mg orally daily until back to baseline bowel movement frequency	Moderate	Strong
Time-efficient acute recovery phase	Discontinue urinary catheter at case end unless contraindicated, consider retrograde fill voiding trial, encourage liberal oral intake and immediate ambulation.	Strong	Strong
Same-day discharge	Criteria for SDD eligibility and for DC home from recovery should be used.	High	Strong

CHO = carbohydrate; CPAP = continuous positive airway pressure; DC = discharge; DMII = type 2 diabetes; DVT = deep vein thrombosis; ERAS = enhanced recovery after surgery; HbA1c = glycated hemoglobin; Hgb = hemoglobin; IV = intravenous; IVF = intravenous fluid; MIGS = minimally invasive gynecologic surgery; NSAIDs = nonsteroidal anti-inflammatory drugs; OSA = obstructive sleep apnea; PCN = penicillin; PONV = postoperative nausea and vomiting; postop = postoperative; preop = preoperative; SDD = same-day discharge; SSI = surgical site infection; VTE = venous thromboembolism.

Table 2

Core considerations pertaining to preoperative patient education and counseling	
Action item	High priority tasks
Make preparations	Preoperative optimization Surgical site infection prophylaxis measures Carbohydrate loading and preoperative fasting instructions
Manage expectations	Pain, vaginal bleeding, and bladder and bowel functions Activity recommendations including pelvic rest (6–12 wk depending on provider recommendations)
Begin discharge planning	Assess eligibility for same-day discharge Urinary catheter/vaginal packing plan Prescriptions for postoperative meds including VTE prophylaxis and hormone replacement therapy
Provide reassurance	Education about safe opioid disposal Repeat, reach out, and remind patient about how to contact providers 24/7

VTE = venous thromboembolism.

considerations pertaining to preoperative patient education and counseling are summarized in [Table 2](#).

Preoperative Optimization

It is well known within the surgical community that lifestyle choices such as tobacco and alcohol use, as well as pre-existing conditions such as anemia, can have a negative impact on perioperative outcomes [14,15]. However, there is no definitive consensus with regard to specific guidelines for preoperative optimization of these risk factors to decrease preventable harm among patients requiring surgery in general or patients requiring MIGS specifically. The following sections will summarize the available data and present it within an enhanced recovery model specifically for women undergoing MIGS.

Anemia

Preoperative anemia, particularly iron-deficiency anemia, is a modifiable risk factor that is highly relevant to gynecologic surgery. The incidence is high in this surgical population, with studies showing that approximately 25% of the women are anemic before elective hysterectomy or myomectomy [16,17]. Data indicate that even grade 1 preoperative anemia (defined as a hemoglobin [Hgb] level <12 g/dL and ≥10 g/dL) is associated with increased 30-day morbidity and mortality among patients undergoing major noncardiac surgery in general and gynecologic surgery specifically. This has proved to be the case even when the gynecologic surgery study population has a low incidence of comorbidities such as cancer, or cardiac or renal

Table 3

Options for correction/prevention of blood-loss anemia	
Intervention	Therapeutic options
Iron supplementation (perioperative)	Oral iron Intravenous iron
Hormonal medications (preoperative)	Combined hormonal contraceptive Levonorgestrel intrauterine device Oral progesterone
Nonhormonal medications (preoperative)	Oral tranexamic acid Ulipristal acetate GnRH agonist
Pharmacologic (intraoperative)	Rectal or vaginal misoprostol Intravenous tranexamic acid Intramyometrial dilute vasopressin Hemostatic agents (e.g., gelatin-thrombin matrix)
Surgical (intraoperative)	Uterine artery embolization Paracervical tourniquet Vascular clamping (temporary or permanent)

GnRH = gonadotropin-releasing hormone.

failure [15,16]. Not surprisingly, preoperative anemia is a strong predictor of perioperative blood transfusion and is associated with increased incidence of alloimmune sensitization, SSI, and prolonged hospitalization [18,19]. The minimum threshold for proceeding with elective surgery should be an Hgb level of 12 g/dL because the risk of transfusion increases exponentially below this level and even low-grade preoperative anemia confers significant risk [17,20]. Whether targeting Hgb-level thresholds >12 g/dL for elective gynecologic surgery further reduces risk is a question of interest.

Patient blood management protocols have 3 pillars: (1) identification and treatment of anemia preoperatively, (2) intraoperative adjuncts to minimize surgical bleeding, and (3) guideline-appropriate use of red blood cell transfusion [21]. In women undergoing elective gynecologic surgery, attempts should be made to achieve a preoperative Hgb level of >12 g/dL with iron supplementation and/or suppression of uterine bleeding. Intraoperative adjuncts (both medical and surgical) to minimize blood loss should also be considered ([Table 3](#)), as should restrictive thresholds for perioperative transfusion (Hgb level <7 g/dL) [22]. Reliance on red blood cell transfusion alone is not a good strategy because correction of anemia with perioperative transfusion has not been shown to sufficiently mitigate adverse postoperative outcomes [16]. Preoperative transfusion has no proven benefit over intraoperative transfusion [23]. Evidence does support preoperative correction of anemia with oral iron in elective, nonurgent cases, and with intravenous (IV) iron for a more severe and timely correction. A review of 14 studies reported a clinically and statistically significant increase in Hgb levels in patients treated with IV iron alone, reporting an increase in Hgb levels by

1 g to 2 g in as little as 1 week [23]. Oral iron should be taken in conjunction with vitamin C because this improves absorption. In women undergoing surgery for benign indications, there is a potential role for preoperative erythropoiesis-stimulating agents to correct anemia in those who are anemic owing to chronic kidney disease or who refuse allogeneic transfusion and are either too anemic or decline autologous blood donation [24–30]. The use of IV iron and erythropoiesis-stimulating agents to correct anemia is prudent in collaboration with a hematologist.

Hyperglycemia

By most recent estimates from the International Diabetes Federation, 1 out of 11 adults is diabetic, and the prevalence of diabetes is predicted to continue to rise. Patients with diabetes, both diagnosed and undiagnosed, who require surgery have higher risks of requiring prolonged postoperative ventilation and critical care, as well as complications, longer lengths of stay, and mortality. Although hyperglycemia is a major risk factor for SSI after open abdominal surgery [31], this association has been less consistently observed in study populations enriched with patients undergoing MIS, including colon operations [32]. Still, there is increasing evidence that hyperglycemia is an easily identifiable, modifiable risk factor that should be addressed in optimizing patients for surgical intervention. Notably, data suggest that it is those patients with previously undiagnosed hyperglycemia who may have the worst outcomes. Furthermore, stress-induced hyperglycemia, which affects 21% of the patients requiring surgery, may not be innocuous [33–36]. Among patients without known diabetes and with a fasting preoperative glucose ≥ 100 mg/dL, 15% were diagnosed with diabetes within 1 year of surgery. In another study of women undergoing surgery with a gynecologic oncologist, 6% of the patients were diagnosed with diabetes with routine preoperative glycated Hgb testing after excluding patients known to have diabetes [37].

Several strategies exist to maintain euglycemia perioperatively, but there is no consensus as to the optimal approach. ERAS protocol implementation should be part of the solution because these protocols are built around minimizing surgical stress and protocol-stipulated CHO loading confers improved insulin sensitivity for up to 72 hours postoperatively [38]. The preoperative oral carbohydrate load versus placebo in major elective abdominal surgery study comparing preoperative oral intake of 800 mL of water containing 100 g of maltodextrin with that of 800 mL of water showed lower rates of perioperative hyperglycemia after CHO loading (24.2% vs 57.4%) [39]. The existing evidence also indicates that preoperative CHO loading is safely tolerated by patients with type 2 diabetes and does not increase glucose levels or insulin requirements [40].

Guidelines regarding perioperative hyperglycemia within existing ERAS protocols are lacking. Until we have more data to establish evidence-based recommendations for point-of-care glucose testing preoperatively, as well as

glycemic goals and standardized protocols for the treatment of preoperative hyperglycemia in populations consisting of patients who qualify for ERAS, we advise the following on the basis of the current literature:

- (1) Glycated Hbg levels within the past 3 years for women with a body mass index (BMI) of ≥ 25 kg/m² and 1 or more risk factors for diabetes, and for women aged ≥ 45 years and no risk factors.
- (2) Glycated Hbg levels within the past 3 months for patients with diabetes.
- (3) Postpone elective surgery for patients with diabetes with glycated Hbg levels $\geq 8.5\%$ to 9% because this corresponds to average daily serum glucose levels of 200 mg/dL to 220 mg/dL over the preceding 3 months. These patients have an increased risk of occult cardiovascular disease and silent ischemia. Optimization will take 3 months [41]. Patients with diabetes with a glycated Hbg level $>6\%$ should be evaluated and optimized by their medical doctor preoperatively.
- (4) Preoperative CHO loading per standard ERAS guidelines in patients without diabetes and patients with type 2 diabetes.
- (5) Treating preoperative glucose values ≥ 180 mg/dL in patients without diabetes in whom CHO has been loaded and who are undergoing major gynecologic surgery is likely unnecessary; the current established guidelines for preoperative glucose treatment thresholds are based on old data from fasting patients
- (6) Although the Surgical Infection Society has advocated perioperative target blood glucose levels of 110 mg/dL to 150 mg/dL for all patients, regardless of a diagnosis of diabetes, a recent meta-analysis of 12 randomized trials (1403 patients with diabetes) showed that intensive perioperative glycemic control was not associated with detectable reductions in infectious complications, cardiovascular events, or mortality. Instead, it was associated with an increased risk of hypoglycemia [42,43]. For patients requiring MIGS who are compliant with the aforementioned preoperative glycated Hbg screening recommendations, routine serum glucose monitoring is unnecessary in patients without diabetes, whereas the serum glucose target should be <180 mg/dL in patients with diabetes.
- (7) Practicing according to these guidelines, diabetes is not a contraindication to SDD [44].

Smoking and Alcohol Cessation

There is strong evidence that a 4-week benchmark for smoking and alcohol cessation before surgery significantly decreases the perioperative risk. Even cutting back on, or quitting, smoking in the week leading up to surgery may be beneficial and is not harmful. However, the best evidence exists only for complete smoking cessation [45].

Furthermore, data indicate that heavy drinkers need to stop drinking for at least 6 weeks to effectively reduce their perioperative morbidity and mortality. Importantly, the National Institute on Alcohol Abuse and Alcoholism defines moderate drinking as up to 1 drink per day or 7 drinks per week and heavy drinking as >4 drinks per day or >7 drinks per week for women. The best strategies for preoperative smoking and alcohol cessation have not been defined. Nicotine replacement therapy increases short-term smoking cessation and may reduce postoperative morbidity. In a recent study, smokers (≥ 10 cigarettes/day) awaiting nonurgent surgery were randomly assigned 3:1 to an offer of free nicotine patches or a control group not offered patches. Approximately 40% of the patients accepted the offer, and 9% quit smoking for ≥ 4 weeks compared with 6% of the patients in the control group, suggesting limited effectiveness in using this approach. Varenicline, a drug used to treat smoking addiction, administered preoperatively has shown some benefits in long-term cessation but no apparent benefit on postoperative complications [46]. Other studies have shown that standardized preoperative referral to smoking cessation programs results in low rates of voluntary participation. In the thoracic literature, mandatory participation in multidimensional smoking cessation programs that involve preoperative support from physicians and tobacco treatment specialists, an exercise prescription, pharmacotherapy, and patient accountability has higher success rates. Intensive preoperative interventions are necessary to correct heavy drinking. If surgery can be delayed and a patient is sincere about smoking/alcohol cessation, then an effort should be made to refer the patient for preoperative rehabilitation.

Obstructive Sleep Apnea

In the United States, a third of adult women are obese [47]. Thus, preoperative assessment and management of obesity-related conditions such as obstructive sleep apnea (OSA) is an important part of optimization for ERAS. OSA is due to a mechanical obstruction of the upper airway resulting in diminished breathing or elimination of breathing. It is estimated that up to half of the patients with OSA may be undiagnosed at the time of surgery [48]. Polysomnography is the gold standard for establishing the diagnosis of OSA. Continuous positive airway pressure (CPAP) is the first-line treatment and is very effective in stenting open the upper airway, but patient compliance is poor. Suitability of ambulatory surgery in patients with OSA remains controversial because of concerns about increased risk of perioperative complications, particularly among patients noncompliant with CPAP, which is estimated to be 29% to 83% [49,50]. The Society for Ambulatory Anesthesia (SAA) clinical practice guidelines for the optimal selection of patients with OSA to undergo ambulatory surgery account for the severity of OSA, coexisting medical conditions, and invasiveness of the surgical procedure [51]. There is a need for large, adequately powered prospective

trials to assess the suitability of patients with OSA for ambulatory surgery. Until these data are available, we recommend the following for women undergoing MIGS on the basis of the SAA and other related consensus guidelines:

- (1) The snoring, tiredness, observed apnea, blood pressure, BMI, age, neck circumference, and gender questionnaire (<https://www.mdcalc.com/stop-bang-score-obstructive-sleep-apnea>) is the preferred screening tool for OSA. It is important to note that up to 25% of the patients with OSA are not obese [52]. The predictive probability of a score of ≥ 3 for any OSA is 72% [53]. One should proceed under the assumption that these patients have OSA because there is no clear evidence that delaying surgery for a sleep study and the use of preoperative CPAP or bilevel positive airway pressure (BiPAP) improves perioperative outcomes. Furthermore, the optimal duration of CPAP or BiPAP therapy before proceeding with elective surgical procedures is unknown. Expert opinion endorses preoperative CPAP for at least 4 weeks before surgery. Still, it seems reasonable to recommend a preoperative sleep study and initiation of CPAP/BiPAP, if indicated, to patients undergoing nonurgent surgery. If not accomplished preoperatively, proceed with postoperative referral. Undiagnosed sleep apnea is an important safety consideration for SDD and has significant negative health impact globally on surgery.
- (2) Patients with a suspected diagnosis of OSA should receive extended monitoring in the postanesthesia care unit (PACU) before admission to an unmonitored floor. Opioids administered intra- and postoperatively have significant propensity to exacerbate OSA and increase the risk of respiratory depression/failure as well as acute respiratory distress syndrome. This risk is particularly prominent during the first 12 hours to 24 hours after surgery. There are data, albeit in older men, suggesting that perioperative gabapentinoid prescribing may pose similar risk [54].
- (3) Patients with a known diagnosis of OSA and optimized medical comorbidities can be considered for ambulatory surgery if they are able to use a CPAP device in the postoperative period and minimize or eliminate narcotics.
- (4) In patients who are obese, OSA is 1 of the 3 most commonly reported independent risk factors for difficult airway management, and these patients should consult with the anesthesiologist preoperatively.
- (5) An opioid-sparing approach to perioperative analgesia should be used. Consider prescribing an atypical opioid, such as tramadol, in lieu of standard opioids. Tramadol is a weaker μ -agonist than standard opioids and has fewer respiratory depression effects.
- (6) Adhere to judicious use of IV fluids. The IV infusion of normal saline (NS) has been shown to acutely and substantially increase neck circumference, resulting in

at least a 3-fold increase in the apnea hypoxia index (AHI). Prolonged periods in a Trendelenburg position compound this.

- (7) Lean bodyweight is the preferred dosing scalar for common anesthetic agents, analgesics, and local anesthetics, except the nondepolarizing neuromuscular blocking agents succinylcholine and sugammadex. Regional anesthesia may have several advantages over general anesthesia for select procedures.
- (8) Patients receiving preoperative CPAP should be advised to use their CPAP device for several days postoperatively. The AHI increases significantly from baseline across the third postoperative night in patients with OSA [55]. The patients should be advised to use CPAP whenever sleeping, even during the daytime.
- (9) Advise against sleeping in the supine position. During the postoperative period, AHI is significantly higher during supine sleep than during nonsupine sleep [56].
- (10) Educate patients and their caregivers regarding the importance of adhering to these guidelines and the need for increased vigilance after discharge home for signs of respiratory depression/failure.

Preoperative Fasting and CHO Loading

Physical stress induced by major surgery produces a postoperative metabolic response that can impair end-organ function and recovery. Minimizing preoperative fasting and prescribing preoperative CHO loading have been shown to reduce these sequelae in multiple prospective randomized studies [47–50]. There are multiple studies protocolizing ingestion of a light, fat-free meal up to 6 hours to 8 hours and clear liquids up to 2 hours to 3 hours preoperatively [57,58]. It has been well-documented within the anesthesia literature that these parameters are safe for delivery of general anesthesia [59]. There is strong evidence from the surgical literature that an ERAS protocol should include preoperative CHO loading with a CHO-rich clear liquid beverage (an approximately 50-gm load) up to 2 hours to 3 hours before surgery because this has been shown to decrease IV fluid requirements, reduce postoperative insulin resistance, and accelerate the return of bowel function without increasing aspiration risk. By inducing a metabolically fed state going into surgery, patients experience improved well-being and less nausea [60,61]. Gastric emptying studies have shown that when up to 400 mL is consumed by patients at least 2 hours before they are administered anesthesia, the residual gastric volume is equivalent to overnight fasting [38]. Some of the most popular CHO-rich beverages are Gatorade (PepsiCo, Purchase, NY) (20 oz/591 mL, 35 g CHOs), Boost Breeze (Nestlé USA, Arlington, VA) (8 oz/237 mL, 54 g CHOs), and Clearfast (CF Nutrition, Cardiff-by-the-Sea, CA) (12 oz/335 mL, 50 g CHOs). Studies have demonstrated the safety of this intervention in patients with type 2 diabetes. Evaluation of preoperative CHO loading in patients with type 2 diabetes has shown that it is not associated with an increased risk of

hyperglycemia or aspiration owing to gastroparesis [62]. This may in part be due to the fact that only 1% of the patients with type 2 diabetes are affected by gastroparesis [63]. Preoperative hydration with “zero sugar” beverages is likely better than no hydration for patients with labile diabetes. Given the strong recommendation for routine-use preoperative hydration and CHO loading in open abdominal surgery, extrapolation to MIS seems logical [59,61].

Postoperative Nausea and Vomiting Prophylaxis

Postoperative nausea and vomiting (PONV) is a significant issue for patients requiring gynecologic surgery. In fact, 3 of the identified risk factors for PONV are female gender, gynecologic surgery, and laparoscopic surgery according to the SAA consensus guidelines for the management of PONV [64]. Therefore, efforts to prevent nausea and vomiting in the postoperative setting are an essential component of an ERAS protocol specialized for MIGS. Ineffective PONV prophylaxis is 1 of the leading reasons for unplanned hospital admission and poor patient satisfaction.

Validated scoring systems have been developed for predicting the risk of PONV. The simplified risk score from Apfel et al [65] is one of the most commonly used scores. The Apfel risk score assigns equal weight to the risk factors of female gender, history of motion sickness/PONV, non-smoking, and opioid use. Patients with 1 risk factor (nearly all patients requiring MIGS, given that female gender is 1 of the 4 Apfel risk factors) have a 20% risk of PONV, and this risk doubles in patients with 2 risk factors. Combination therapy for PONV prophylaxis is preferable to single drug. Apfel et al [66] demonstrated that the effects of antiemetics acting on different receptors are additive. Given this, and the fact that there are other very pertinent independent risk factors for PONV, such as laparoscopic gynecologic surgery and young age (<50 years), and that the most likely causes of PONV are volatile anesthetics, nitrous oxide, and postoperative opioids, we recommend the following prophylactic measures for patients requiring MIGS in line with the SAA consensus guidelines [64]:

- (1) Consumption of clear liquids up to 2 hours to 3 hours before the procedure.
- (2) Use conscious sedation or locoregional anesthesia instead of general anesthesia when possible; use alternatives to volatile anesthetics and nitrous oxide, such as propofol infusion.
- (3) Limit or eliminate narcotics.
- (4) Administer pre-emptive antiemetics:
Patients with 1 risk factor to 2 risk factors (20%–30% risk of PONV): dexamethasone 8 mg IV administered preoperatively or 5HT₃ receptor blocker ondansetron 4 mg IV at case end. Ondansetron 4 mg and dexamethasone 4 mg have been shown to be equally effective, each independently reducing PONV risk by approximately 25% [66].
Patients with ≥ 3 risk factors (most patients, >50% risk of PONV): dexamethasone 8 mg IV administered

preoperatively and 5HT₃ receptor blocker ondansetron 4 mg IV at case end; consider application of scopolamine transdermal patch (evening before surgery or 2 hours before surgery).

- (5) If dexamethasone and/or ondansetron are contraindicated, consider oral aprepitant capsules (generic) 40 mg within 3 hours of induction, or midazolam 2 mg IV 30 minutes before case end.
- (6) If nausea is linked to high anxiety, consider midazolam 2 mg IV administered preoperatively.
- (7) If prophylaxis fails within 6 hours postoperatively, use rescue antiemetic from different class than prophylactic drug(s) (e.g., promethazine 6.25 mg IV to 12.5 mg IV, prochlorperazine 10 mg IV, haloperidol 1 mg IV or intramuscular, meclizine 50 mg taken by mouth). If the emetic episode is >6 hours postoperatively, a retrial of ondansetron can be considered. The combination of haloperidol with the 5HT₃ receptor antagonists has not been shown to increase the risk of QT prolongation. Of note, the use of haloperidol as an antiemetic and the IV route of administration are off-label.
- (8) If no prophylaxis was given, first-line treatment should be a low-dose 5HT₃ antagonist such as 4 mg IV ondansetron [67,68].
- (9) If postdischarge nausea and vomiting is anticipated for a patient who is SDD-eligible (e.g., patient with nausea and emesis in PACU despite adequate prophylaxis), consider a discharge prescription for ondansetron 8 mg taken by mouth every 8 hours for 24 hours.

There is good rationale for administering 8 mg IV dexamethasone preoperatively as opposed to administering it at induction of anesthesia. Preoperative dexamethasone 8 mg has been found to enhance post-discharge quality of recovery, in addition to reducing nausea, pain, and fatigue [69]. At 24 hours, patients receiving dexamethasone 0.1 mg/kg vs 0.05 mg/kg required less opioid and reported less nausea, sore throat, muscle pain, and difficulty falling asleep [70]. A meta-analysis evaluating the dose-dependent analgesic effects of perioperative dexamethasone found that doses >0.1 mg/kg are an effective adjunct in multimodal strategies to reduce postoperative pain and opioid consumption. In most studies, a single dose of perioperative dexamethasone does not seem to increase the risk of wound infection [71–73]. Recent studies have shown significant increases in blood glucose 6 hours to 12 hours postoperatively in most patients requiring surgery [74,75]. In view of this evidence, the use of dexamethasone in patients with labile diabetes is relatively contraindicated.

Strategies found to be ineffective for PONV prophylaxis include music therapy, isopropyl alcohol inhalation, intraoperative gastric decompression, the proton pump inhibitor esomeprazole, ginger root, nicotine patch for nonsmokers, cannabinoids (nabilone and tetrahydrocannabinol) and intraoperative supplemental oxygen [64].

Multimodal Opioid-Sparing Analgesia

Acute pain management plays an important role in reducing perioperative morbidity and achieving patient satisfaction [76]. Ineffective pain control plays a major role in prolonging length of stay, increasing the risk of postoperative complications, and compromising the quality of recovery [77]. Interestingly, women are more likely to report higher levels of postoperative pain than men [78]. High levels of acute postoperative pain are associated with an increased risk of chronic postsurgical pain, although there is limited evidence that pre-emptive and prophylactic analgesia meaningfully reduce the development of chronic postsurgical pain syndromes [79]. Offering a minimally invasive approach to hysterectomy and other pelvic surgery is the first step in the pain management plan.

The use of multimodal pain interventions to reduce the reliance on opioids is a defining feature of all ERAS protocols. ERAS should be the context in which we standardize perioperative opioid prescribing. To date, multimodal analgesic regimens for MIS have relied heavily on nonopioid pharmacologic agents (e.g., nonsteroidal anti-inflammatory drugs [NSAIDs], acetaminophen, and gabapentinoids), use of locoregional anesthetics, and adjunct therapies such as dexamethasone. Prescribing should account for patient factors such as age, hepatorenal function, and pre-existing substance dependency, as well as the surgery performed. The premise of multimodal analgesia is that combining different analgesics that act by different mechanisms and at different sites in the nervous system results in additive or synergistic pain control [80,81]. Preoperative dosing of nonopioid pharmacologic agents and adjuncts has been shown to translate into improved pain and decreased opioid need/consumption later in the surgical course [82].

Although many ERAS pathways have included preoperative IV acetaminophen, there is no evidence to support IV over oral administration in minimally invasive hysterectomy (MIH) [83]. Both celecoxib and ketorolac have been shown to effectively reduce postoperative pain [84], and are not associated with a measurable increased risk of bleeding [85]. There seems to be improved acute pain control when NSAIDs are combined with local anesthetic port-site infiltration compared with either singular intervention during MIH [86,87]. In addition to a reduction in PONV, preoperative dexamethasone has analgesic properties and can serve the dual function of nausea and pain prophylaxis [88,89]. Anticonvulsants such as gabapentin and pregabalin decrease opioid consumption and narcotic use in abdominal hysterectomy [90]. In MIH, pregabalin has an opioid-sparing effect when given preoperatively [91,92]. In these studies, pregabalin was not administered in combination with other prophylactic medications. Thus, the benefit it adds to multimodal analgesic regimens on ERAS protocols remains unknown. A recent randomized controlled trial of preoperative acetaminophen (975 mg) and celecoxib (400 mg) plus gabapentin (600 mg) vs placebo was negative [93]. These

findings, along with the recent Food and Drug Administration warning about serious, life-threatening, and fatal respiratory depression with gabapentinoids, particularly when taken concomitantly with other central nervous system depressants such as opioids and benzodiazepines, have resulted in their discontinuation from some ERAS protocols. Safety concerns are highest for patients who are SDD-eligible. Other adverse effects include somnolence (20%), dizziness (8%), ataxia (13%), and fatigue (11%). Phenazopyridine (pyridium) 200 mg is a relatively low-risk intervention that can be given preoperatively as a urogesic and has been shown to increase voiding trial success rates [94]. Table 4 formulates a multimodal medication bundle for MIGS on the basis of these data. The various analgesic techniques that have been evaluated in the intraoperative phase of care are summarized below.

Intraoperative medications

Intraoperative medications intended to prevent postoperative pain include IV ketorolac, ketamine, lidocaine, and opioids [95]. It is theorized that the prevention of postoperative pain is a more effective strategy for minimizing postoperative pain and opioid consumption than the rescue treatment of pain. This has prompted the use of various interventions in the operating room to augment the beneficial effect of the multimodal premedication bundle on the prevention of postoperative pain. However, the impact of many of these when used as part of an ERAS protocol that includes a premedication bundle, port-site infiltration with local anesthetics, and ketorolac at procedure end remains unknown.

Ketorolac

Ketorolac is a nonselective cyclooxygenase inhibitor with potent anti-inflammatory and analgesic effects. Although evidence supports its inclusion in multimodal pain management regimens for MIS procedures, the ideal timing of IV ketorolac administration for pain prophylaxis perioperatively is debated. There are no prospective studies to inform this. However, the consensus opinion of experts is to administer ketorolac 30 minutes before case end to delay its antiplatelet effects until this time point, and achieve postoperative analgesia. As mentioned, there is also evidence that ketorolac augments surgical site pain control with local anesthetic infiltration. The standard parenteral dose recommended by the manufacturer for patients who are healthy and nonelderly is 30 mg on the basis of a number of clinical trials. However, several existing studies have demonstrated that the analgesic efficacy of ketorolac at 10 mg is similar to that of higher doses—15 mg and 30 mg—for the treatment of postoperative or cancer pain as well as for patients presenting to the emergency department with acute pain [96–99].

Table 4

Standard multimodal medication bundle for minimally invasive gynecologic surgery

Phase of care	Medications
Premedication bundle (2 hr before OR)	Ibuprofen 600 mg or Celecoxib 400 mg (CI if sulfa allergy) po once if GFR \geq 30 Tylenol (Johnson & Johnson, New Brunswick, NJ) 1 gm po once Dexamethasone 8 mg IV once (omit for patients with labile diabetes) Scopolamine transdermal patch for high-risk PONV Phenazopyridine 200 mg po once Heparin 5000 units SC if indicated
Intraoperative (30 min before case end)	Antibiotics if indicated Local anesthetic port-site infiltration Ketorolac 15 mg IV once Ondansetron 4 mg IV once
Discharge	Tylenol 650 mg po q6hr scheduled, and then prn Ibuprofen 600 mg po q6hr scheduled, and then prn; alternate with Tylenol Oxycodone 5 mg or equivalent alternative q6hr prn* Phenazopyridine 200 mg po q8hr if urinary catheter Ondansetron 8 mg po q8hr \times 24 hr if high risk for PDNV Lovenox (Sanofi-Aventis, Cambridge, MA) 40 mg SC daily \times 28 days if indicated Hormone replacement therapy if indicated (transdermal patch preferred during the first 28 days postoperatively) Senokot (Avrio Health, Stamford, CT) 8.6 mg po daily until back to baseline bowel movement frequency

CI = contraindicated; GFR = glomerular filtration rate; IV = intravenous; OR = operating room; PDNV = postdischarge nausea and vomiting; po = by mouth; PONV = postoperative nausea and vomiting; prn = as needed; q6hr = every 6 hours; q8hr = every 8 hours; SC = subcutaneously.

* Consider a scaled number of opioid tablets at discharge for inpatients. If the inpatient opioid pill use 24 hours before discharge is 0 pills, then prescribe 5 pills (consider 0 pills); if 1 pill to 4 pills, then prescribe 15 pills; if \geq 5 pills, then prescribe 30 pills (1 pill = 5 mg oxycodone immediate release or 2 mg hydromorphone; 7.5–8 morphine equivalents per pill).

Ketamine

Ketamine has been used as an adjunct for pain management pre-, intra-, and postoperatively. The analgesic effects of ketamine are primarily mediated through the N-methyl-D-aspartate receptor pathway and are not known to compromise respiratory drive or cardiovascular tone. A recent

systematic review of 47 randomized controlled trials showed a consistent reduction in postoperative opioid consumption among patients who received ketamine intraoperatively as a bolus or infusion, with the greatest efficacy observed for upper abdominal, thoracic, and major orthopedic procedures. The opioid-sparing effect of intraoperative ketamine infusion was highest among patients with maximum visual analog scale—equivalents higher than 7 out of 10 [100]. However, the neuropsychiatric adverse effects of ketamine deter its widespread use. An international double blind randomized controlled trial evaluated the effect of low- and high-dose IV ketamine (0.5 mg/kg or 1.0 mg/kg) vs placebo (NS) on postoperative pain and delirium in adults aged 60 years and above undergoing major surgery. There were more neuropsychiatric adverse events (hallucination and nightmares) with increasing doses of ketamine compared with placebo without a reduction in postoperative pain [101]. Thus, the risk-benefit ratio is likely unsatisfactory for surgery associated with mild pain, such as MIGS for opioid naive patients on ERAS, where the visual analog scale—equivalent of <40% of the maximum score on any pain scale is typically reported by patients. Still, ketamine may be useful in patients anticipated to have high pain scores after MIGS (e.g., opioid tolerant patients) because the drug acts primarily through a different mechanism than opioids and has been shown to be effective for patients undergoing laparoscopic gynecologic surgery when given as a preincision bolus of 0.03 mg/kg to 0.5 mg/kg [102]. At this dose, it prevents hyperalgesia, allodynia, and tolerance. Thus, ketamine could be considered as an opioid-sparing adjunct in opioid tolerant patients, but should not be routinely used as part of multimodal pain management regimens for MIGS owing to its risk of neuropsychiatric adverse effects.

IV Lidocaine

Intraoperative IV lidocaine infusion is an option for pre-emptive analgesia, and has been studied in patients requiring gynecologic surgery who underwent both open [103] and laparoscopic [104] procedures. Yardeni et al [103] examined the effect of lidocaine infusion (initiated 20 minutes before surgery start) vs placebo (saline infusion) in patients undergoing abdominal hysterectomy. Patients receiving the lidocaine infusion in this study reported lower resting visual numeric pain scores 4 hours (4.5 vs 4.0, $p = .03$) and 8 hours (4.3 vs 3.7, $p = .01$) postoperatively, but not at any other time point up to 72 hours postoperatively [103]. Postoperative opioid use was not an outcome in this study. A randomized controlled trial of patients undergoing laparoscopic gynecologic procedures demonstrated no difference in the primary end point of opioid consumption among patients who received lidocaine infusions intraoperatively (initiated postinduction and continued until 20 minutes to 30 minutes before skin closure) compared with placebo control (saline infusion) [104]. There were no differences in pain scores on postoperative days 1 and 2. Given

that intraoperative lidocaine infusion has not been shown to reduce postoperative opioid use after MIGS, and that its clinical utility measured by decreased pain scores is questionable, it should not be routinely used as part of multimodal pain management regimens for MIGS. Importantly, care must be taken to avoid systemic lidocaine toxicity in MIGS where port-site infiltration of lidocaine is common [105]. There has been no direct comparison of IV infusion and port-site infiltration of lidocaine. Lidocaine infusion could be considered as an adjunct intervention for patients predisposed to high levels of postoperative pain after MIGS (e.g., opioid tolerant patients).

IV Opioids

IV opioids are often administered intraoperatively to treat physiologic signs of pain, such as tachycardia, in patients who are otherwise stable and euvolemic, and to prevent postoperative pain. Studies evaluating the effect of opioids used in these ways suggest that this practice may be ineffective and may increase the occurrence of hyperalgesia in the immediate postoperative period. A systematic review and meta-analysis of 27 studies including 1494 patients showed that patients who received higher doses of opioids intraoperatively reported higher pain levels 1 hour, 4 hours, and 24 hours after surgery and consumed more morphine milligram equivalents of opioids in the PACU as well as during the initial 24-hour postoperative period. These results largely apply to the short-acting opioid, remifentanyl, with inconclusive data pertaining to the effects of other types of IV opioids [106]. Congruently, many studies have examined the use of esmolol, a β -1 receptor antagonist, instead of IV opioids, to treat physiologic stress in the operating room to avoid precipitating hyperalgesia in response to IV opioid administration [95]. A recent systematic review and meta-analysis showed that administering esmolol to treat intraoperative signs of physiologic stress translates into lower intra- and postoperative opioid administration. Postoperative pain was not quantifiably different between the patients who received esmolol and those administered placebo or treated with IV opioids [95]. Thus, IV opioids should not be reflexively given to treat physiologic signs of pain (i.e., tachycardia) intraoperatively.

Pain Prevention Procedures and Techniques

Port-site Infiltration with Short-acting Local Anesthetic Agents versus Liposomal Bupivacaine

Port-site infiltration with short-acting local anesthetic agents has minimal risk, is low-cost, and has been shown to decrease pain perception among patients requiring MIGS in the immediate postoperative period. None of the studies included in a recent review of randomized controlled trials of pre-emptive analgesia for MIGS found either preincision or preclosure incision blocks to measurably decrease postoperative analgesic requirements. Thus, data are lacking on

the optimal timing of incisional blocks (preincision or pre-closure), particularly when performed in concert with other ERAS interventions [102].

Liposomal bupivacaine is a long-acting preparation of bupivacaine designed for controlled release over 72 hours. Studies in patients who underwent laparoscopic and open surgeries have not demonstrated a reduction in postoperative opioid use after SSI with liposomal bupivacaine compared with a short-acting bupivacaine [107,108]. In addition, the high cost of liposomal bupivacaine impedes its widespread use, given the low-cost effective alternative of short-acting bupivacaine.

Regional Blocks

Transversus abdominis plane (TAP) blocks, paracervical blocks, and superior hypogastric plexus (SHP) blocks are types of regional nerve blocks that can be performed to target local anesthetics to the sensory nerves activated during laparoscopic gynecologic surgery. The TAP block aims to deposit local anesthetic in the fascial plane between the internal oblique and transversus abdominis muscles. The most commonly performed lateral TAP block primarily anesthetizes the lower TAP plexus with a dermatomal spread of T10 to L1 on the anterior abdominal wall. Although some studies have shown that preoperative TAP blocks afford small reductions in postoperative pain scores and opioid use compared with both placebo (saline infiltration) and port-site infiltration with local anesthetic, others have not [102]. Furthermore, a meta-analysis (although not restricted to patients who underwent laparoscopic or gynecologic surgeries) demonstrated that the patients who received TAP blocks reported only a modest reduction in pain scores and did not use less opioids postoperatively [109].

There are also mixed results from the few studies evaluating the effects of paracervical blockade on postoperative pain in women undergoing laparoscopic gynecologic surgery. A randomized controlled trial demonstrated an improvement in immediate postoperative pain scores (30–60 minutes posthysterectomy) [110], whereas another did not demonstrate a benefit in women undergoing supracervical hysterectomy [111]. Given these conflicting results and heterogeneous patient populations, further research is warranted to determine the potential benefit and appropriate target population for this intervention.

SHP blockade consists of laparoscopically guided infiltration of local anesthetic into the retroperitoneal space overlying the superior hypogastric nerve plexus near the sacral promontory. There are limited data supporting the effectiveness of this technique in patients requiring MIGS. The only study, a single nonrandomized prospective trial, suggested that SHP may reduce postoperative pain along with opioid and NSAID consumption [112]. The complexities of this procedure, the required surgeon learning curve, and the potential associated risks preclude its widespread use.

In conclusion, TAP blocks, paracervical blocks, SHP blocks, and liposomal bupivacaine injection should not be

routinely used as prophylactic pain measures in patients undergoing laparoscopic gynecologic surgery owing to the lack of consistent evidence that these procedures have a sustained effect on postoperative pain; reduce postoperative opioid use; or are worth the additional cost, time, and associated risks. Paracervical blocks or SHP blocks could be considered for, and studied prospectively in, patients at high risk for postoperative pain (e.g., patients with a history of chronic opioid use). However, the learning curve associated with performing a hypogastric plexus block may preclude its use even in this specific patient subgroup.

Postoperative Opioid Prescribing for Narcotic-Naive Patients

Opioids, although highly effective in controlling acute pain, have a number of adverse effects that conflict with the ERAS mission, including PONV, respiratory depression, delirium, hyperalgesia, gastrointestinal dysfunction, urinary retention, immunosuppression, and addiction even after short-term use. Minimization of perioperative opioid prescribing and use should be a major outcome measure for enhanced recovery programs intended for MIGS. Recently published prescribing practices are reshaping guidelines for dispensing postdischarge opioids. After MIH, most women only use half of the opioids prescribed [113]. A recent systematic review of perioperative opioid use in this instance recommends that prescribers closely evaluate each patient and strive for needs-based opioid prescribing, highlighting that most patients use fewer than 10 oxycodone 5-mg equivalents at the time of hysterectomy [114]. The Michigan Surgical Quality Collaborative and Opioid Prescribing Engagement Network has gone on to publish opioid-prescribing recommendations for MIH, and recommends dispensing no more than 15 tablets for all types of hysterectomy: vaginal, abdominal, and laparoscopic/robotic approaches [115]. Unless a contraindication exists, a combination of NSAID and acetaminophen taken on alternating schedules provides sufficient pain control for many patients over the duration of their postoperative recovery after MIGS. However, young age, nonwhite race, less education, history of sleep dysfunction, current tobacco/alcohol use, high scores on fibromyalgia screening administered preoperatively, and high anxiety are associated with higher pain severity and/or excess postoperative opioid use [116]. When patients are admitted for a brief postoperative stay, there is more opportunity for precision medicine. In a small, prospective study of opioid naive women undergoing MIH, inpatient opioid requirements were compared with outpatient use. Inpatient use was a predictor of opioid consumption after discharge [117]. More than half of the opioids prescribed were not used (median prescribed quantity: 30 tablets of oxycodone 5-mg equivalents), and a third of the patients required no opioids after discharge. Thus, inpatient opioid use in oral morphine equivalents in the time leading up to hospital discharge may be the best way to calibrate postdischarge opioid prescribing.

Postoperative Opioid Prescribing for Narcotic-Tolerant Patients

New challenges arise in the perioperative care of opioid-tolerant patients because they are at increased risk for difficult-to-control and persistent postsurgical pain, acute opioid tachyphylaxis, and opioid-induced hyperalgesia [118]. Opioid-tolerant patients may experience greater-than-expected pain during the first 24 hours postoperatively, and have analgesic requirements that significantly surpass those of opioid naive patients. Preoperative referral to a provider specializing in pain management should be considered for patients with high baseline opioid intake (>50 morphine milligram equivalents daily); a history of substance abuse; a history of chronic pain syndromes; or current treatment with methadone, buprenorphine, or naltrexone. Patients should be advised to take their maintenance opioids on the morning of surgery. Gabapentinoids should also be continued in patients who take them at baseline. Beyond the routine ERAS interventions of multimodal preoperative medication bundle administration, ketorolac 30 minutes before case end, and port-site infiltration with local anesthetic, opioid-tolerant patients may derive unique benefit from locoregional nerve blocks as well as from ketamine or lidocaine infusion. Eligibility for SDD should be carefully appraised, and rare use of postoperative patient-controlled analgesia may be warranted. Opioid dependent patients should be discharged on their preoperative regimen, in addition to supplemental opioids for postsurgical pain control. Consultation with providers specializing in acute pain can lend additional support to safe and effective discharge opioid prescribing. Opioid weans should be avoided perioperatively.

Considerations Related to Pneumoperitoneum

Hypothermia can increase surgical blood loss, the risk of wound infection, cardiac complications, and aberrant drug metabolism [119,120].

Standard-pressure pneumoperitoneum (12 mmHg–16 mmHg) can precipitate deleterious changes in blood circulation. Some have advocated for the use of low-pressure pneumoperitoneum to circumvent this, and to decrease postoperative pain. However, lower pressures can compromise visibility and working space in the operative field, which can increase the risk of direct as well as thermal injury to adjacent organs [121,122]. In a Cochrane review of 1092 patients in 21 studies, low-pressure pneumoperitoneum resulted in decreased pain scores during the early postoperative period, but definitive conclusions could not be drawn from the meta-analysis because 20 of the 21 studies scored high for bias and low for quality [123]. Two systematic reviews of the gynecologic literature demonstrated reductions in postoperative pain scores, albeit minimal, and the trade-off was a compromise in surgical-field visualization. Thus, use of low-pressure pneumoperitoneum to

decrease pain in the context of an ERAS protocol for MIGS is unsupported by efficacy and safety data [124,125].

IV Fluid Goals

IV fluids are among the most dangerous medications that surgeons prescribe. One liter of NS has the salt load of 3.5 party-size bags of Lay's brand potato chips (PepsiCo, Purchase, NY) [126]. By comparison, a liter of lactated Ringer's solution has about 30% less salt (6 g compared with 9 g), but this is still substantial. The increase in intravascular hydrostatic pressure that occurs with hypervolemia owing to excessive IV fluid administration damages the endothelial glycocalyx. Injury to the glycocalyx from fluid overload in the intravascular compartment results in extravasation into the interstitial space [127]. Interstitial edema has multiple deleterious effects, including respiratory compromise, gastrointestinal dysfunction, and impaired wound healing [128,129]. In contrast, hypovolemia owing to under-resuscitation can compromise end-organ perfusion and cause lactic acidosis. Acute kidney injury is one of the most common manifestations of this.

In a randomized observer-blinded multicenter trial, the highest fluid balance hospitals were found to have higher postoperative major and minor complications as well as longer lengths of stay, independent of complications and case complexity [128]. In a population-based study that included 64 hospitals looking at outcomes after intestinal resections, hysterectomies, and abdominopelvic endovascular procedures, high fluid balance hospitals had a 12% to 14% longer risk-adjusted length of stay, independent of complications and case complexity. Of the 22 854 hysterectomies performed at these 64 hospitals, 62.6% were performed laparoscopically and 9.2% vaginally [130]. A multicenter randomized trial comparing patient outcomes associated with restrictive vs liberal fluid regimens showed higher rates of acute kidney injury and SSI among fluid restricted patients [131].

Thus, judicious administration of IV fluids to maintain euvolemia is one of the most important ERAS interventions. Maintenance of euvolemia is more easily attainable with ERAS protocols than with traditional surgical care owing to protocolization of preoperative hydration and CHO loading as well as perioperative fluid management. Retrospective reviews of patients undergoing MIGS on ERAS protocols have shown that patients on the protocol receive substantially less intraoperative and total inpatient IV fluids [132]. On the basis of existing data, ERAS protocols for MIGS should incorporate the following fluid management principles: [133]

- (1) Fluid therapy should be based on patient factors and not on individual practice patterns.
- (2) Thoughtful fluid administration to reach zero-balance (maintain euvolemia) is the goal.

- (3) Oliguria in the absence of other signs of hypovolemia should not be an indication for fluid therapy.
- (4) Use buffered isotonic crystalloids (e.g., lactated Ringer's and Plasma-Lyte [Baxter International Inc, Deerfield, IL]) for intraoperative maintenance fluids at a rate of 1 mL/kg/h to 3 mL/kg/h.
- (5) In MIGS, pneumoperitoneum and positioning of the patient can impact stroke volume and cardiac output independent of changes in blood volume. Consider these factors when making decisions about increasing IV fluid administration.
- (6) Use 200 mL to 250 mL of colloid (e.g., albumin) infused over 5 minutes to 10 minutes to test fluid responsiveness.
- (7) Do not reflexively order "maintenance" continuous IV fluids postoperatively unless oral intake is not tolerated.

Infection Prophylaxis

Hysterectomy is categorized as a clean-contaminated type of surgical case, and the risk of SSI with hysterectomy is 2.4% to 7.7%, depending on a number of risk factors: age, nutritional status, diabetes, smoking, obesity, immunocompromise, coexistent infections or colonization with microorganisms, and cancer. The most important factors in SSI prevention for MIGS are timely administration of appropriate preoperative antibiotics (most often a cephalosporin for MIH) and meticulous surgical technique. Importantly, SSI rates are higher when β -lactam alternatives are used, and their use should be restricted to those with a history of IgE-mediated penicillin hypersensitivity reactions, including urticaria (not just rash), angioedema, and anaphylaxis [134]. Recently, the American College of Obstetricians and Gynecologists (ACOG) convened the Council on Patient Safety in Women's Health Care. After reviewing existing SSI-reduction guidelines and evidence-based recommendations, the Council released practice recommendations for a patient care bundle that, although aimed at preventing SSI in women undergoing hysterectomy, can be applied to all gynecologic surgery. Although there are few studies in the MIGS population, data exist to support the use of SSI-reduction bundles in this population [135–137].

The interventions for SSI risk-reduction pertinent to MIGS are summarized in Table 5. There is task force consensus that 4% chlorhexidine gluconate solution should be used for vaginal preparation; the strength of this recommendation is strong and is based on moderate-level evidence. Although the manufacturer's label in the United States states that chlorhexidine gluconate is for external use only and should not be used in genital areas because of concern for allergic reactions or irritation, several studies, including 1 randomized study, reported no significant adverse effects from vaginal application of chlorhexidine. Although trials examining the role of bacterial vaginosis screening and treatment with metronidazole in the context of a positive test before hysterectomy have not been conducted in the era

Table 5

Surgical site infection prevention bundle components

Surgical site infection prevention bundle

Preoperative

- Consider bacterial vaginosis and UTI screening/treatment
- Use of chlorhexidine 4% wipes/wash the night before and morning of surgery
- Cessation of smoking for ≥ 4 wk
- Glycemic control

Intraoperative

- Appropriate timing, selection, and dose of prophylactic antibiotic(s)
- Hair clipping
- Skin/vaginal prep with chlorhexidine 4%
- Sterile technique and meticulous hemostasis
- If bowel resection or contaminated procedure performed, redrape, regown/glove, and use only clean instruments for closing
- Maintain normothermia and euvoolemia
- Limit duration of surgery
- Discontinue urinary catheter at case end, unless otherwise indicated

Postoperative

- Remove dressings within 24 hr
- Maintain euvoolemia
- Serum glucose < 180 mg/dL in patients with diabetes
- Discontinue urinary catheter in the OR or by midnight, unless contraindicated

OR = operating room; UTI = urinary tract infection.

of prophylactic antibiotic use, the ACOG and Centers for Disease Control and Prevention recommend that it is reasonable to screen and treat asymptomatic bacterial vaginosis before hysterectomy to prevent postprocedure vaginal cuff infection [138–140].

VTE Prophylaxis

VTE prophylaxis for MIGS is a controversial topic. When perioperative compliance with mechanical prophylaxis (e.g., sequential compression devices) alone is high ($> 95\%$), VTE events are observed in 0.1% to 0.3%, and 0.4% to 1.6% of minimally invasive surgical cases for benign and malignant gynecologic disease, respectively [141–143]. Given these low rates of VTE, as well as a lack of data demonstrating benefit with VTE prophylaxis in MIGS beyond intraoperative mechanical prophylaxis and immediate postoperative ambulation, some have argued against prescribing more than this even in cancer cases. Others follow the best available national guidelines from the ACOG and American College of Chest Physicians (ACCP). This lack of consensus results in huge practice variation in the use of thromboprophylaxis for MIGS, which is inconsistent with the ERAS mission of evidence-based care standardization [144].

The ACOG recommendations for VTE prophylaxis are adapted from the ACCP, which uses the Caprini scoring system for VTE-risk assessment [145,146]. The Caprini scoring system for VTE-risk assessment is believed to be transferrable to gynecologic surgery, but has never been prospectively validated in patients requiring gynecologic treatment. Adding to this limitation, the Caprini scoring system does not risk-stratify by surgical approach (open vs MIS), and the historic cut points for surgical time (>45 minutes) as well as BMI (>25 kg/m²) result in an overestimation of VTE risk for patients undergoing MIGS and likely minimally invasive abdominal-pelvic surgery in general. For example, most of the women undergoing MIGS have a baseline Caprini score of 4, signifying moderate VTE risk of approximately 3%. However, in reality only a fraction of this risk (0.1% to 0.3%) is observed with MIHs. Furthermore, more than 95% of the women with newly diagnosed gynecologic cancer have a Caprini score of ≥ 5 , which is purportedly associated with a VTE risk of approximately 6%. However, numerous retrospective cohort studies totaling more than 10 000 women who underwent MIGS for cancer indicate that the risk is 0.4% to 1.6%, substantially less than 6%. Nonetheless, the ACCP recommends that all patients undergoing abdominal or pelvic surgery for cancer receive extended pharmacologic thromboprophylaxis for 28 days postoperatively.

The ACCP advocates prescribing heparin up to 2 hours preoperatively in all surgical groups as a “general consideration for good clinical practice [146].” However, the ACCP acknowledges that this recommendation is based on low-quality evidence. Thus, there is currently no consensus on the use and timing of preoperative thromboprophylaxis in patients undergoing MIGS. However, given that the pathophysiology underlying VTE formation at the time of surgery is well established and that the risk is incurred on initiation of anesthetic induction, most instances of deep vein thrombosis (DVT) associated with gynecologic surgery are assumed to form either in the operating room or within 24 hours of surgery. In most of the trials that demonstrate the efficacy of heparin pharmacoprophylaxis, heparin was given up to 2 hours preoperatively, and beginning 6 hours postoperatively. Thus, we recommend that women undergoing MIGS who have an inherited thrombophilia, a history of VTE, or active cancer receive preoperative pharmacoprophylaxis, with 5000 units of unfractionated heparin (UFH) given subcutaneously (SC) up to 2 hours preoperatively, and then every 8 hours [147]. An alternative is 40 mg of enoxaparin SC 2 hours to 4 hours preoperatively and then every 24 hours [148]. All patients should also receive perioperative mechanical prophylaxis with sequential compression devices because this intervention is known to enhance venous return and to stimulate the endogenous fibrinolytic system [149]. Early and frequent ambulation in recovery also plays a major role in clot prevention after

MIGS, and ERAS patient education as well as postoperative order sets should include this.

Given the lack of prospective randomized trials addressing VTE prophylaxis in MIGS, the limited predictive value of Caprini scoring in these patients, the unaccounted-for VTE risk factors pertinent to patients with gynecologic cancer in the current Caprini scoring system, and the recent finding that the VTE incidence is 1.2% among patients requiring gynecologic surgery with a Caprini score of 5 with odds ratios for VTE of 1.08, 1.71, and 2.07 for Caprini scores of 6, 7, and ≥ 8 [150], respectively, we propose the following strategy for extended VTE prophylaxis (Table 6):

- (1) All patients with an inherited thrombophilia or history of VTE should receive 5000 units of UFH SC up to 2 hours preoperatively, perioperative combination mechanical and pharmacologic prophylaxis, and extended pharmacoprophylaxis for 28 days postoperatively. Alternatively, 40 mg of enoxaparin SC 2 hours to 4 hours preoperatively, and then every 24 hours, may be prescribed.
- (2) Perioperative mechanical prophylaxis alone is sufficient for patients undergoing routine benign MIGS who do not have an inherited thrombophilia or history of VTE.
- (3) Patients with gynecologic cancer should receive 5000 units of UFH SC up to 2 hours preoperatively (or enoxaparin 40 mg SC 2 to 4 hours preoperatively) and perioperative combination mechanical and pharmacologic prophylaxis. To identify candidates for extended pharmacoprophylaxis, we recommend using a modified Caprini score contemporizing BMI to ≥ 40 kg/m² and surgical time to ≥ 180 minutes (Table 7), as well as stratifying Caprini scores of 5 to 6 by the most relevant surgicopathologic risk factors from the literature: high-grade histology, known or suspected stage III/IV disease, and lymphadenectomy. Thus, extended prophylaxis should be strongly considered for women undergoing MIGS for cancer who have a modified Caprini score of 5 to 6 and high-grade histology or known/suspected stage III/IV disease or lymphadenectomy (sentinel lymph node biopsy excluded); or a modified Caprini score of ≥ 7 .

When administering extended VTE pharmacoprophylaxis in women undergoing MIGS for a gynecologic malignancy, we recommend treatment for a total of 28 days postoperatively (as opposed to 9 days or 2 weeks as others have proposed) because median time to VTE diagnosis after MIS for cancer is 10 days to 11 days [151,152]. Enoxaparin 40 mg SC daily is most commonly prescribed for extended VTE pharmacoprophylaxis. However, there are emerging data that the direct oral anticoagulant apixaban is a potentially safe alternative [153].

Table 6

Venous thromboembolism prophylaxis recommendations for minimally invasive gynecologic surgery

Patient category	Preop	Intraop	Postop	Extended postop
Benign indications				
VTE or hereditary thrombophilia history	5000 units UFH SC given up to 2 hr before induction of anesthesia [†]	SCDs	SCDs Early ambulation 5000 units UFH SC every 8 hr or 40 mg LMWH SC daily beginning 8 hr from preop dose of UFH	Frequent ambulation 40 mg LMWH SC daily or prophylactic dose DOAC for 28 d
No history of VTE or hereditary thrombophilia and not on hormonal therapy	None	SCDs	SCDs Early ambulation	Frequent ambulation
On hormonal therapy	5000 units UFH SC given up to 2 hr before induction of anesthesia [†]		SCDs Early ambulation 5000 units UFH SC every 8 hr 40 mg LMWH SC daily beginning 8 hr from preop dose of UFH	Frequent ambulation
Malignant indications				
1) mCaprini score* of ≥ 7 or	5000 units UFH SC given up to 2 hr before induction of anesthesia [†]	SCDs	SCDs	Frequent ambulation
(2) mCaprini score* of 5 to 6 and high grade histology, stage III/IV disease, or		Early ambulation		40 mg LMWH SC daily or
Lymphadenectomy (SLN biopsy excluded)		5000 units UFH SC every 8 hr or 40 mg LMWH SC daily beginning 8 hr from preop dose of UFH		Prophylactic dose DOAC for 28 d
Not meeting criteria (1) or (2) above	5000 units UFH SC given up to 2 hours before induction of anesthesia [†]	SCDs	SCDs Early ambulation 5000 units UFH SC every 8 hr 40 mg LMWH SC daily beginning 8 hr from preop dose of UFH	Frequent ambulation

DOAC = direct oral anticoagulant (e.g., apixaban 2.5 mg orally twice daily); Intraop = intraoperative; LMWH = low molecular weight heparin; Preop = preoperative; Postop = postoperative; SC = subcutaneously; SCDs = sequential compression devices; SLN = sentinel lymph node; UFH = unfractionated heparin; VTE = venous thromboembolism.

* Modified Caprini score using a BMI of ≥ 40 kg/m² instead of 25 kg/m² and surgical time of 180 minutes instead of 45 minutes.

[†] LMWH in the form of enoxaparin 40 mg SC given 2 hours to 4 hours before induction of anesthesia and every 24 hours thereafter is an alternative.

Thromboprophylaxis: Additional Special Considerations Relevant to MIGS

Hormonal Contraceptives and Hormone Replacement Therapy

There are no data to suggest that the discontinuation of hormonal therapy preoperatively decreases the risk of postoperative VTE among women undergoing MIGS for benign

indications [147]. A recent Danish nationwide cohort study showed that the use of oral hormonal contraceptives or hormone therapy did not influence the hazard ratio of VTE in women undergoing hysterectomy for benign disease. Most of the patients (58.6%) received postoperative pharmacologic thromboprophylaxis leading up to discharge home [154]. A recent systematic review examining the association of surgical risk with exogenous hormone use in

Table 7

Modified Caprini risk assessment for minimally invasive gynecologic surgery

1 point	2 points	3 points	5 points
Age 41–60 y	Age 61–74 y	Age ≥ 75 y	Stroke (<1 mo)
Minor surgery	Major open surgery (>45 min)	History of VTE	Hip, pelvis, or leg fracture
BMI ≥ 40 kg/m ² *	Minimally invasive surgery (≥ 180 min)*	Family history of VTE	Acute spinal cord injury (< 1 mo)
Swollen legs	Malignancy	Factor V Leiden	Elective arthroplasty
Varicose veins	Bed rest (>72 hr)	Prothrombin 2021A	
Pregnancy or postpartum	Immobilizing plaster cast	Lupus anticoagulant	
Swollen legs	Malignancy	Factor V Leiden	Elective arthroplasty
Varicose veins	Bed rest (>72 hr)	Prothrombin 2021A	
Pregnancy or postpartum	Immobilizing plaster cast	Lupus anticoagulant	
History of unexplained or recurrent spontaneous abortion	Central venous access	Anticardiolipin antibodies	
Oral contraceptives or hormone replacement	Arthroscopic surgery	Elevated serum homocysteine	
Sepsis (<1 mo)		Heparin-induced thrombocytopenia	
Severe lung disease, including pneumonia (<1 mo)		Other congenital or acquired thrombophilia	
Abnormal pulmonary function			
Acute myocardial infarction			
Congestive heart failure (<1 mo)			
History of inflammatory bowel disease			

BMI = body mass index; VTE = venous thromboembolism.

* Modifications.

transgender patients concluded that current evidence does not support the need to routinely discontinue all cross-sex hormone therapy before surgery. Specifically, there is insufficient evidence to support routine discontinuation of testosterone. However, the data for estrogen are mixed, and decision-making should be individualized [155]. The ACOG has advised that if patients are expected to be ambulatory postoperatively, there is no reason to stop combined hormonal contraception perioperatively [156]. The ACOG also recommends inpatient postoperative pharmacologic thromboprophylaxis for all patients requiring MIGS except healthy women aged 40 years or below having had surgery lasting less than 30 minutes [145]. Thus, these data and the present ACOG guidelines support the continuation of hormonal therapy perioperatively in benign MIGS provided that the patients receive thromboprophylaxis as outlined in Table 6. If hormonal therapy is held before elective surgery, this needs to occur 4 weeks to 6 weeks in advance because it takes this long for the hemostatic effects associated with hormonal therapy to resolve. It is worth mentioning that current evidence suggests that combination oral contraceptive pills containing ≥ 35 μg of ethinyl estradiol and a second-generation progestin are associated with the lowest risk of VTE [157].

More than half of all hysterectomies are performed for women aged 45 years or younger, and a significant

proportion of these women will undergo concomitant bilateral oophorectomy for an increased genetic risk of ovarian/breast cancer or other benign conditions [158]. Premenopausal bilateral oophorectomy causes a rapid decline in circulating ovarian estrogens and androgens, leading to the onset of hot flashes, sleep disturbance, mood alteration, and cognitive impairment in the immediate postoperative period [159,160]. This has a negative impact on patient quality of life, function, and recovery back to baseline. Data from a recent prospective multicenter observational study showed that women who start hormone replacement therapy (HRT) immediately after risk-reducing salpingo-oophorectomy may experience a smaller burden of endocrine symptoms than women who delay HRT initiation [161]. These and similar data indicate that estrogen therapy is most beneficial when started at the time of oophorectomy and continued at least until age 50 years [160]. Studies comparing multiple hormone regimens have shown that transdermal preparations do not seem to increase hemostatic parameters associated with thrombosis. Thus, a plan for initiation of HRT should be made preoperatively with premenopausal patients planning elective bilateral oophorectomy. The initiation of HRT at the time of discharge home after benign MIGS is likely safe and beneficial. Transdermal preparations should be the preferred form of HRT in the immediate 4-week postoperative period.

Preoperative VTE Assessment in Women with Large Uterine Leiomyomas

Thromboembolic disease has been described as a rare complication of uterine leiomyomas. There are no large-scale studies investigating this association in patients with no other risk factors for VTE.

Extrinsic mechanical compression of the pelvic venous system, most typically the common iliac veins and inferior vena cava, leading to stasis and subsequent thrombosis is thought to be the proposed mechanism by which a large uterine leiomyoma may be associated with thromboembolic events. Lower extremity swelling as well as hydroureter on imaging may be findings suggestive of clinically significant mechanical compression, venous stasis, and occult thrombosis. Leiomyoma-related bleeding and iron-deficiency anemia also likely contribute by inducing a hypercoagulable state as evidenced by an increase in factor VIII and erythropoietin levels. Elevated erythropoietin levels may in turn lead to the development of thrombocytosis, further increasing clot risk [162]. There are no guidelines for preoperative VTE screening in patients with large uterine leiomyomas. Although some experts define “large” to be a leiomyoma ≥ 10 cm, a better metric is probably uterine weight ≥ 1000 g [163]. Shiota et al [164] examined the relationship between DVT and uterine leiomyoma size/weight by assessing preoperative DVT rate with respect to age, BMI, and uterine size/weight in 361 patients with uterine leiomyomata. Although there was no difference in DVT rate according to age or BMI, the rate of DVT was significantly higher for patients with uterine weights ≥ 1000 g (11%) compared with weights < 1000 g (3%) [164]. Clinical assessment has been shown to be at least as accurate as ultrasound in predicting uterine weight preoperatively; a nongravid uterus measuring 20 weeks’ size on clinical examination (fundal height at the umbilicus) corresponds to a uterine weight of approximately 1000 g [165]. Thus, a review of the published reports of VTE in association with uterine leiomyomata suggests that a preoperative assessment for DVT may be prudent in leiomyoma cases where the estimated uterine size/weight is ≥ 1000 g and/or there is coincident iron-deficiency anemia, thrombocytosis, lower extremity swelling, and/or hydroureter on imaging [166–169].

The Postoperative Care Phase

The postoperative phase of care is key to the success of ERAS for MIGS. All patients qualifying for ERAS should be re-identified as such in the PACU. Similar principles apply to patients qualifying for SDD and those admitted to the inpatient unit. Activities in the inpatient unit should mirror those necessary for return home.

IV fluids should be discontinued on departure from the operating room. Liberal oral intake of fluids and solid food should be permitted. This results in earlier return of bowel function, reduced length of stay, and higher patient

satisfaction with no evidence of higher complication rates [170]. Gum chewing should be encouraged for similar reasons [171]. It is acceptable to continue preoperatively placed scopolamine patches for 72 hours after surgery because this intervention has been shown to reduce the amount of IV rescue antiemetics needed postoperatively [172]. However, patients should be instructed to remove the patch at home if they are still wearing it on discharge. The administration of rescue postoperative antiemetics should be guideline adherent. Immediate postoperative ambulation likely has the greatest positive impact on postoperative recovery because it reduces thromboembolic complications, decreases insulin resistance, minimizes deconditioning, and results in shorter hospital stays [173].

As aforementioned, multimodal opioid-sparing analgesia should continue postoperatively. A common example of a multimodal opioid-sparing pain regimen includes an oral NSAID such as celecoxib 200 mg twice daily or ibuprofen 600 mg every 6 hours, in addition to acetaminophen 650 mg every 6 hours on an alternating schedule. Discharge opioid prescribing should not exceed 15 tablets of oxycodone 5-mg equivalents. Prescribing tramadol as a substitute for opioids is discouraged owing to the unpredictable pharmacokinetics of this drug [174]. Gabapentin 100 mg to 600 mg 3 times per day for 7 days had been a standard recommendation in the past because gabapentin has been shown to decrease narcotic use and, in turn, decrease constipation [175]. However, the recent Food and Drug Administration warning about respiratory depression, particularly when taken in combination with opioids, has brought to light risk in excess of benefit. This most notably applies to geriatric patients (> 65 years) and patients with renal impairment [176]. Emerging evidence suggests that a scheduled, multimodal pain regimen that includes perineal ice packs offers improved pain control for up to 96 hours after vaginal surgery, and decreases narcotic use [177]. There is insufficient evidence to support the routine use of lidocaine patches and abdominal binders after MIGS.

ERAS protocols for MIGS should include a postoperative bowel regimen; this is particularly important for patients who have undergone pelvic floor reconstructive surgery. Bowel regimens with docusate only have not been shown to decrease time to first bowel movement after MIGS (range 3–5 days) [178]. In fact, multiple randomized trials have failed to show any significant efficacy of docusate over placebo [179]. Data from a randomized controlled trial indicate that the addition of senna (8.6 mg daily) may reduce time to first bowel movement by 1 day. In this study, more subjects in the placebo group needed to use magnesium citrate to initiate a bowel movement [180]. Among patients undergoing pelvic floor reconstructive surgery, pharmacologic management of constipation does not seem to reduce the amount of pain with the first bowel movement, suggesting that patients may need additional counseling about what to expect with bowel movements after reconstructive procedures. On the basis of available

evidence, senna is a reasonable discharge medication for the proactive management of constipation after MIGS.

The incidence of urinary retention after robotic and laparoscopic hysterectomy has been reported to be 0.2% to 7% [181]. A randomized controlled trial in patients undergoing hysterectomy showed that the removal of indwelling catheters immediately after surgery did not increase the risk of recatheterization, but did reduce the risk of urinary tract infections and subjective pain experienced by patients compared with catheter removal the following day [182]. Retrograde fill voiding trials have been shown to be superior to spontaneous voiding in identifying bladder dysfunction. In patients who have voiding trials performed the day after vaginal prolapse surgery, failure rates have been reported to be as high as 40%. A voiding trial is commonly considered unsuccessful if the patient emptied <50% of instilled fluid into the bladder or had a postvoid residual ≥ 150 mL. In such cases, patients should be offered reinsertion of the urinary catheter or intermittent self-catheterization [183]. Huang et al [184] studied patients undergoing anterior colporrhaphy with or without hysterectomy and reported that voiding dysfunction with catheter removal was not more on postoperative day 2 than on postoperative day 4.

Data regarding the utility of vaginal packing are mixed [185], and in circumstances of suspected bleeding it may be beneficial, but in general it should be avoided because it causes discomfort, delays urinary catheter discontinuation, and limits ambulation [173]. Options for discontinuation of urinary catheters and/or vaginal packing among patients otherwise meeting discharge milestones include return to an outpatient nursing clinic or a homecare nursing visit depending on insurance.

SDD

SDD is common for patients with cardiac, cholecystectomy, and orthopedic conditions after minimally invasive procedures [186]. Currently, an estimated 0.1 million to 0.2 million MIHs are performed in outpatient settings annually. Many retrospective and prospective studies over the past 30 years and more have compared SDD with overnight admission after MIH and have reported that SDD is safe, feasible, cost-effective, and carries a low risk of complications and readmission [187]. A recent Cochrane systematic review examining SDD outcomes among 11 992 patients who underwent MIH corroborated this finding, with the caveat being that it largely pertained to women who underwent benign MIH [188]. Only 14.2% of the patients included in the Cochrane analysis had cancer as an indication for surgery. Consistent with this, several studies have demonstrated that the uptake of SDD after MIH for endometrial cancer has been low, with less than 10% of the cases discharged home the day of surgery. Although providers may advocate for overnight inpatient observation to monitor for potential perioperative complications, data indicate that this practice does not improve the recognition of, or

result in, a decrease in 30-day postoperative complications, including reoperation and hospital readmission. SDD has potential for major direct cost savings by eliminating daily inpatient hospitalization charges estimated to be approximately \$2200, as well as for indirect positive financial impact by increasing throughput [189]. SDD is also associated with increased patient satisfaction; several studies report a high satisfaction rate with outpatient MIH ($\geq 90\%$) [181,190–194]. Thus, given the advantages of SDD for MIH, it should be an important quality metric for gynecologic surgery service lines. Some programs have leveraged ERAS as a mechanism to address overly high inpatient admission rates after MIGS [195].

Although SDD is defined as discharge home before midnight on the same day as surgery, benchmarking studies indicate that the goal time in the PACU should be 4 hours to 6 hours or less [196,197]. Having the option of an extended PACU stay or transfer to a 24-hour observation unit where patients can still be discharged home if meeting criteria or admitted overnight as indicated improves SDD success rates [195]. The SDD rate achieved and reported in the literature to date is influenced by a variety of factors, including the availability of functional units such as this, as well as the use of particular ERAS pathway components, study design, target patient population, surgical volume, and procedural complexity. For example, consistent intraoperative use of ketorolac has been associated with increased odds of SDD [196]. SDD rates are also higher when they are prospectively tracked, when eligibility criteria are followed, and when high-volume surgeons are performing MIH early in the day (surgery start time before 1 P.M. to 2 P.M. and end time before 6 P.M.) and without concomitant reconstructive or oncologic procedures. These same factors heavily influence 30-day urgent care center/emergency department visit and readmission rates after SDD. Still, most existing data suggest that SDD does not result in a significant change in the number of contacts between the patient and the healthcare system. In fact, these rates are generally lower than those observed for patients admitted for overnight observation. Median readmission and re-evaluation rates are approximately 1% and 7%, respectively, in prospective trials of SDD [198]. On the basis of experience to date, goal SDD rates for benign MIH should be 80% in the first year of implementation, with >90% achievable thereafter. Given that patients requiring gynecologic oncology treatment tend to be older, more comorbid, and undergo longer, more complex procedures, goal SDD rates for malignant MIH might be closer to 50% in the first year of implementation, with >80% achievable thereafter [186].

There is no agreement in the literature regarding the preoperative eligibility criteria for SDD. Those included in Table 8 are based, in part, on the preoperative factors associated with an increased risk of requiring 30-day readmission. There is general consensus that patients requiring therapeutic anticoagulation, those with poorly controlled medical comorbidities, and those without an escort or

Table 8

Patient criteria for planned-for overnight admission after minimally invasive gynecologic surgery

Patient criteria

Sociodemographic criteria

Poor social network, lacking at least 1 family member or friend reachable by phone and who can provide care in the first 24 hours after discharge

Distance between patient's home and hospital >60 miles

Age ≥ 80 yrs

Impaired cognition

Impaired mobility (e.g., ECOG performance status ≥ 2)

Medical criteria

American Society of Anesthesiologists score ≥ 3

History of anesthesia complications

Sleep apnea

Poorly controlled asthma or COPD

On therapeutic anticoagulation

History of arrhythmia, CHF, pacemaker/AICD, or HTN requiring >3 medications

Type 1 diabetes or poorly controlled type 2 diabetes (blood glucose >180 mg/dL preoperatively)

Significant underlying kidney disease (GFR <30 mL/minute)/dialysis)

Cirrhosis

Daily alcohol consumption >2 drinks

AICD = automated implantable cardioverter defibrillator; COPD = chronic obstructive pulmonary disease; CHF = congestive heart failure; ECOG = Eastern Cooperative Oncology Group; GFR = glomerular filtration rate; HTN = hypertension.

Table 9

Postoperative criteria for same-day discharge

Postoperative criteria

Surgical criteria

Case end before 6 P.M.

Absence of any intraoperative complication

Expected estimated blood loss

Patient criteria

Blood pressure, heart rate, and respiratory rate within normal or baseline range

Oxygen saturation >92%

Afebrile

Alert, awake, and appropriately conversant

Adequate pain control with oral medications (pain intensity VAS $\leq 4/10$)

Minimal nausea and absence of vomiting

Able to ambulate independently

Able to void volitionally or Foley catheter plan in place

VAS = visual analog scale.

All criteria must be met for a patient to qualify for same-day discharge.

adequate help at home in the first 24 hours after discharge are ineligible for SDD. Advanced age (≥ 80 years), history of stroke, extreme obesity (BMI >50), and sleep apnea are considered relative contraindications for SDD. Generally speaking, the risk factors that precipitate the referral of patients to a center for preoperative optimization/clearance and those that render a patient ineligible for SDD are the same.

Many studies have published recommended postoperative criteria for patients who are SDD-eligible. These are summarized in Table 9. There are data to suggest that minilaparotomy to facilitate the intact removal of surgical specimens need not be a contraindication to SDD [181]. Most agree on the necessity for acceptable vital signs, postoperative pain/nausea control, ambulation, and voiding (or discharge plan for urinary catheter) for patients at increased risk of urinary retention (e.g., those who have undergone a pelvic procedure and/or had urinary catheterization perioperatively). Current practice guidelines set out by the American Society of Anesthesiologists Task Force on Postanesthetic Care recommend that drinking clear fluids should not be part of a discharge protocol, but may only be necessary for select patients, such as patients with diabetes. De-emphasizing this criterion avoids unnecessary delays and supports patient-focused care [199]. Pain, nausea, and urinary retention are the 3 most

common indications for admission. Thus, the key to minimizing admissions is optimal prescribing of pain and nausea prophylaxis, as well as having established protocols to enable discharge with a urinary catheter or intermittent self-catheterization. Furthermore, improved preoperative preparation and education to clearly set patient expectations, timing of surgery (scheduling as first case of the day), and postoperative education of nursing and allied health staff are vital to the success of an SDD program [181]. Table 10 summarizes the SDD phases of care for MIGS.

Conclusion

Over the past 2 decades, thousands of publications dedicated to ERAS have appeared in the peer-reviewed literature. This White Paper, put forth by the AAGL ERAS Task Force, represents the first concerted and collaborative effort to standardize the perioperative care of women undergoing MIGS on the basis of a systematic review of this literature as it relates to the ERAS fundamentals of (1) preoperative patient education and optimization; (2) multimodal and narcotic-sparing analgesia; (3) nausea, SSI, and VTE prophylaxis; (4) maintenance of euolemia; and (5) liberalization of activity. The resulting guidelines are intended to serve as a contemporary and comprehensive evidence-based tool for the design and implementation of ERAS protocols specialized for MIGS. The task force endeavored to benchmark specific ERAS interventions against standard of care where possible. However, better understanding of the relative contributions of discrete ERAS protocol elements to recovery after MIGS is still needed. Currently, there is a national effort to centralize data on patients undergoing open surgery and MIGS on enhanced recovery pathways through the Agency for Healthcare Research and Quality Safety

Table 10

Same-day discharge phases of care for minimally invasive gynecologic surgery

Preadmission	Preop and OR	Postop care unit	Postdischarge
Eligibility screening	Preoperative medications	Same-day discharge expectation communicated to nursing in patient sign-out	Follow-up nurse-led phone calls on postoperative day 1
Education and counseling setting clear expectations	Sequential compression devices	Active voiding trial	Verbal notification of surgeon if concern arises
Hormone therapy and urinary catheter plans	TIVA	Offer patient coffee/tea and chewing gum	Outpatient surgeon follow-up
Assessment of indication for perioperative VTE prophylaxis	Local anesthetic at port sites	Criteria-based clearance for discharge home by anesthesiologist or surgeon	
Discharge prescriptions including an as-needed antiemetic and instructions for managing constipation	Ketorolac and antiemetic at skin closure		
Schedule surgery as first start	Foley removed in the operating room; consider backfilling bladder with 200 cc sterile saline to decrease time to voiding		
Call patient the day before surgery to review instructions			

OR = operating room; Preop = preoperative; Postop = postoperative; TIVA = total intravenous anesthesia; VTE = venous thromboembolism.

Program for Improving Surgical Care and Recovery. However, the process and outcomes measures tracked are very gynecologic oncology-centric. This reflects the customary practice of enhanced recovery for MIGS according to protocols designed for open gynecologic surgery owing to lack of more relevant options. There is optimism that this will now change with the provision of a MIGS-specific enhanced recovery protocol. The present White Paper improves on the guidelines for perioperative gynecologic/oncology surgery put forth by the ERAS Society in 2016 as they pertain to MIGS [171,200]. This is pivotal because most gynecologic surgery is now performed using minimally invasive approaches. The synthesis and adoption of a MIGS-specific enhanced recovery protocol also introduces new opportunities to fulfill our duty as gynecologists to better the health of the women who seek our care and to make value-based improvements in the service that we deliver. Importantly, the teamwork and safety culture that follow from the protocolization of surgical care through enhanced recovery are necessary for our health system to transform, particularly in response to crisis.

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