Anesthesia protocol for bariatric surgery: A quality improvement process

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Abstract

Objective: The purpose of this quality improvement process was to review current enhanced recovery after surgery (ERAS) protocols for bariatric surgeries, analyze the current anesthesia protocol used at a midwestern medical center, and propose potential system modifications for best practice in the bariatric surgical population. *Methods*: All articles published between 2009 and March 2019 that contained specific keywords were critically appraised or discarded. Additional articles were discovered through cross references from previously found articles. *Major points*: The midwestern medical center protocol reviewed followed ERAS guidelines closely. Both parties agreed on the use of antiemetics, multimodal analgesics, positioning, oxygen therapy, and use of a neuromuscular blocking agent followed by reversal. The midwestern medical center was more specific in some areas but all remained within recommendations by ERAS. ERAS guidelines were more complete in recommendations for lung protective strategies and intravenous fluid management. Conclusion: Many of the elements included in the midwestern medical centers protocol, if not already in agreement with ERAS guidelines, was supported by more recently published studies. Recommendations for the midwestern medical center were made as potential system modifications with the intent of minimizing perioperative complications in the bariatric patient population.

Keywords: Bariatrics, bariatric surgery, enhanced recovery after surgery protocol, gastric bypass, and gastric sleeve.

Introduction

Obesity, as defined by the World Health Organization as a body mass index (BMI) of 30 or more, is a growing worldwide issue. Bariatric surgery as a treatment for obesity was introduced in the 1950s, with minimally invasive approaches being used today. Enhanced recover after surgery (ERAS) protocols were introduced by Kehlet and colleagues in the late 1990s focusing on multimodal programs in colorectal surgery.[1] Over the last two decades, ERAS protocols have combined multimodal perioperative elements that aid in the reduction of physiological stress, accelerate the return of bodily function, and decrease overall costs by decreasing hospital length of stay.[2] Accordingly, the ERAS Society published an official ERAS Society Guideline for Perioperative Care in Bariatric Surgery in 2014. Although a major benefit of ERAS protocols is reduction in cost, implementing these programs in the obese surgical population may lead to improved clinical outcomes.[3] Alterations in practice are necessary when caring for bariatric patients as they are often accompanied by medical co-morbidities, many of which are complex and high-risk.[2]

The purpose of this quality improvement process is to review current ERAS protocols for bariatric surgeries, analyze the current anesthesia protocol used at a midwestern medical center, and propose potential system modifications for best practice in the bariatric surgical population focusing on anesthetic implications. Specifically, the questions that guided this quality review were:

1. What are the benefits of utilizing anesthesia components in ERAS protocols for bariatric surgeries compared to standard care?
2. What anesthesia components are included in current ERAS protocols for bariatric surgeries?

3. What research supports individual recommendations within the ERAS protocols?
4. Does the anesthesia protocol for bariatric surgeries at a midwestern medical center follow current best practice recommendations?

Methods

Bryan Fusion was used to review literature related to ERAS protocols for bariatric surgeries; search engines included MEDLINE Complete, CINAHL Complete, Academic Search Elite, Education Research Complete, ERIC, Psychology & Behavioral Sciences Collection, Science & Technology Collection, GreenFILE, eBook Collection (EBSCOhost), Cochrane Database of Systematic Reviews, Bryan Library Catalog, Nursing Reference Center Plus, Research Starters, and OpenDissertations. Terms used alone and in combination included *bariatric, surgery, enhanced recovery after surgery, ERAS, gastric bypass, gastric sleeve, obesity, and obese.* Additionally, the ERAS Society, American Society of Enhanced Recovery, and the Centers for Disease Control and Prevention (CDC) were also searched. These search engines found 128,789 articles. The search was then narrowed down to the following terms used alone or in combination, "bariatric, bariatric surgery, and enhanced recovery after surgery", retrieving 213 articles. Inclusion criteria were limited to articles written in the English language. All articles published between 2009-2019 that contained the keywords were included for examination. Articles were discarded following review of the title or abstract if they did not associate with surgical operations or ERAS protocols. Duplicates of articles were eliminated. Additional articles were discovered through references from previously found articles.

Review of Literature

ERAS Society Recommendations for Perioperative Care in Bariatric Surgery

Postoperative nausea and vomiting

Prevention of postoperative nausea and vomiting (PONV) is one of many concerns for anesthesia providers. Not only is it an unfavorable experience for the patient but also increases their risk for aspiration, results in extended PACU stays, and poses potential medical risks following bariatric surgeries.[4,5] Anesthesia providers must be able to identify individual factors that may lead to increased risk of PONV and treat prophylactically.[4,6] Many patients presenting for bariatric laparoscopic surgeries have a number of factors that increase their risk for PONV including being of the female gender, less than 50 years old, a non-smoker, with procedure time exceeding one hour, and most receive opioids for pain control postoperatively.[6]

Glucocorticoids are regularly recognized for their anti-emetic and anti-inflammatory effect, ERAS recommends administering 8 milligrams (mg) of dexamethasone 90 minutes prior to induction.[6] Although the references cited by the ERAS society for its use as an anti-inflammatory are not from random control trials (RCTs) in bariatric surgeries, their recommendation for its use is high.[6] Conclusions from an RCT that specifically analyzed dexamethasone for its anti-inflammatory effects on perioperative morbidity and mortality support this proposal.[7] Though the trial was stopped after the second analysis, due to the determination that no single intervention reduced 1 year mortality or major morbidity, conclusions were made that out of all three interventions (dexamethasone, light anesthesia, and tight glycemic control), dexamethasone alone decreased inflammation.[7] Exact optimal dose, especially when combined with other antiemetic medications, has yet to be determined.[8] References cited by ERAS determined the minimal effective dose of dexamethasone to be between 2.5-5mg with 5mg being equally as effective as 10mg.[9–11] Reference made to the consensus guidelines for the management of PONV published in 2014 by ERAS showed that an

8mg dose improves level of fatigue and quality of recovery following discharge home in addition to reducing PONV.[12]

Guidelines published by the ERAS society recommend the preferred time of administration for dexamethasone to be 90 minutes prior to induction.[6] Two studies cited included administration of the medication with general anesthesia, but time of administration in those studies was at or immediately before induction.[9,10] The other study reviewed its effects for prophylaxis following epidural morphine for post-cesarean analgesia.[11] Optimal time for administration of dexamethasone was not conclusive in cited studies by ERAS, but the consensus guidelines for management of PONV recommends administering dexamethasone at time of induction.[12]

Recommendations by ERAS include using a multimodal approach to prevent PONV as indicated by the 2014 consensus guidelines for management of PONV.[12] These guidelines showed a decreased incidence of PONV from 52% when no antiemetics were utilized, to 37%, 28%, and 22% with the addition of 1, 2, and 3 antiemetics, respectively, were administered.[12] Recommended multimodal drug classifications include 5-hydroxytryptamine receptor antagonists, corticosteroids, butyrophenones, neurokinin-1 receptor antagonists, antihistamines, and anticholinergics in addition to propofol for induction and maintenance and minimization of opioid and intravenous fluid administration.[6,12] ERAS specifically mentions haloperidol and ondansetron in combination with dexamethasone as showing superior effects in two studies when all three medications were used together.[13,14] Feng et al.,[15] supports this with their findings in an RCT examining the prophylactic effect of haloperidol with ondansetron. These medications together contributed to the lowest nausea scores, lowest incidence of PONV throughout all time intervals, and highest patient satisfaction. Additionally, the risk of QT prolongation was not

increased when the combination of haloperidol with ondansetron was used.[15] Nontraditional antiemetic medications have also been largely studied as their use in clinical practice is beginning to grow. Though not included in the ERAS guidelines or the 2014 consensus guidelines for management of PONV, more recent studies indicate the benefits of midazolam in assisting with prevention of PONV.[16,17]

Airway management

ERAS recognizes that the airway in bariatric patients can present specific challenges, referring to studies by Cattano et al.,[18] and Leoni et al.,[19] that found bag and mask ventilation difficult in up to 15% of bariatric patients. Conclusions from a larger study by Kheterpal et al.,[20] that included 22,660 mask ventilation attempts, correspond with these findings as they recognized a BMI > 30 as an independent predictor of difficult or impossible mask ventilation. Anatomic changes that develop in obese patients include excess adipose tissue deposits within the upper airway, face, neck and abdomen.[21] This excess soft tissue impacts the ability to adequately mask ventilate the patient along with decreasing chest wall compliance, expiratory reserve volume (ERV), functional residual capacity (FRC), and diaphragmatic excursion, predisposing many of these patients to obstructive sleep apnea.[21]

A recommendation that tracheal intubation be utilized for safe airway management in obese patients was included in the ERAS society guidelines.[6] Their reference to a Cochran review published in 2013 compared two studies that included 232 obese patients in all, both comparing tracheal intubation with use of the a supraglottic airway device.[22] However, both coincidently examined the use of the ProSeal laryngeal mask airway (LMA) for general anesthetics. It was determined that providers can expect a 3-5% failure rate when using an LMA in the obese population leading to need for airway securement with a tracheal tube.[22] Although

literature supporting the use of supraglottic airways in obese patients is scarce, Murphy and colleagues[21] suggest having a supraglottic airway immediately available in the anticipated or unanticipated event of a difficult mask ventilation or intubation for obese patients, but should be used with caution.

Guidelines by ERAS do not recommend one intubating device over the other as results from a Cochran review was unable to demonstrate efficacy of a specific intubating device when comparing a flexible intubation scope (FIS), direct or indirect laryngoscopy, and intubating supraglottic airway device for obese patients.[23] Though controversial, many studies show lack of association of obesity with likelihood of difficult intubation.[24] Inconsistency in these findings may largely be due to the variability in definition of difficult intubation between studies. The American Society of Anesthesiologists (ASA) 2013 practice guidelines for management of the difficult airway suggests, but does not limit the definition of a difficult tracheal intubation as one that "requires multiple attempts, in the presence or absence of tracheal pathology". Nevertheless, anesthesia providers should be prepared for a difficult airway with each case. Patient positioning, clinician experience, and laryngoscopy technique used (whether video or direct), all influence intubation success.[21] Enhanced recovery after surgery society discussed positioning the patient in the ramped position, referencing a study by Collins et al.,[25] that included 60 morbidly obese patients undergoing general anesthesia randomly assigned into one of two groups. One group was placed in the supine position with a firm 7-cm cushion underneath their head in the "sniffing" position the other group placed in the "ramped" position to achieve a horizontal alignment between the external auditory meatus and sternal notch from stacked blankets. The patients in the "ramped" position were found to have a significantly improved laryngeal view compared to the "sniffing" position.[25]

Neuromuscular blockade

Choice of neuromuscular blocker (NMB) administered, careful monitoring of its effects, and ensuring full reversal must be well-thought-out prior to induction as part of an anesthetic plan. This is particularly true in the obese population, as they often present with a number of potential problems including an already compromised respiratory function, increased risk of obstruction, and potential for difficult mask ventilation.[20]

The ERAS society guidelines recommend the use of a NMB to improve surgical performance.[6] Establishment of a pneumoperitoneum leads to significant changes hemodynamically as well as physiologic effects on multiple organ systems including the respiratory system.[26] Use of deep neuromuscular blockade for laparoscopic bariatric surgeries can help facilitate a better surgical view without further increasing intrabdominal pressure.[6,27] The amount of intraabdominal pressure from a pneumoperitoneum determines the level of effects seen in the patient.[28] Compression of the inferior vena cava occurs at approximately 20 mmHg intraabdominal pressure and causes a decrease in venous return to the heart and adverse effects to the kidneys in the non-obese population. Along with these effects, obese patients also experience a more substantial increase in systemic vascular resistance from aortic compression and increased release of vasopressin compared to the non-obese population.[28] Data referenced by the ERAS protocol in support for deep blockade was collected mainly from two small trials performed in non-bariatric surgeries, one trial consisting of 48 patients[29] and the other with only 24 patients.[30] An additional study discussed a single, obese, high-risk cardiac patient undergoing laparoscopic surgery to allow the patient eligibility for a heart transplant in which deep NMB was successfully used in order to promote a low-pressure peritoneum.[31] Results in this particular subject are scarce but the potential benefits of its use may be more beneficial to the bariatric

population. Thompson et al.,[32] utilized complete muscle relaxation to help facilitate ventilation and prevent collapse of the pneumoperitoneum, in discussion of anesthesia management for bariatric surgery.

Use of objective qualitative monitoring of NMB is encouraged by ERAS guidelines, recognizing that utilization of nerve-stimulated monitoring along with a train of four (TOF) ratio of 0.9 lead to advantages in recovery.[33,34] Studies have repeatedly shown a correlation between residual blockade and complications in post-anesthesia care units (PACUs).[6] One review cited by ERAS suggested that residual blockade, as defined as a TOF<0.9, was found in an estimated 40% of patients in the post-anesthesia care unit (PACU).[33]

Finally, ERAS recommends full reversal of neuromuscular blockade to improve patient outcome.[6] Successive administration and timing of a neuromuscular blocker should be based on the pharmacological response observed, which includes close monitoring of neuromuscular blockade with a peripheral nerve stimulator.[6] Repetitive administration can result in its accumulation in adipose tissue and result in a prolonged effect.[28] Though they do not recommend specific medications, recent findings discussing use of deep neuromuscular blockade for laparoscopic bariatric procedures suggest superiority with the use of an aminosteroid neuromuscular blocker in combination with sugammedex for reversal.[27] A study by Thilen et al.,[35] studied 150 patients, evaluating the frequency of residual paralysis within 5 minutes of admission to PACU in patients reversed with neostigmine and found that 41% of the patients had a TOF ratio of less than 90%. The use of sugammedex improves the ability to prevent residual paralysis postoperatively[28] and its use in bariatric surgeries is largely supported.[35]

Monitoring anesthetic depth

Bispectral index (BIS) monitoring evaluates a single, frontal electroencephalogram (EEG) electrical signal and displays the processed information as a numerical value between 0 and 100.[26] The displayed value represents the anesthetic depth or level of consciousness of the patient.[26] Although BIS monitors have not shown to be superior when compared with end-tidal concentration of an anesthetic agent[36–38], ERAS recommends considering BIS monitoring of anesthetic depth when end-tidal anesthetic gas (ETAG) monitoring is not used.[6]

Though ERAS did not include evidence or resources for their recommendation of the use of BIS when ETAG monitoring is excluded, it is reasonable to accept that monitoring of anesthetic depth of another kind should be used when ETAG is not employed. The B-Aware Trial completed in 2010 demonstrated comparable results between BIS and ETAG when monitoring level of consciousness in patients under general anesthesia, stating that its use reduced the risk of awareness in high-risk, adult patients.[39] Though results were argued by a study that included 1,473 patients undergoing noncardiac surgery, stating that BIS is no more effective than ETAG,[36] BIS monitoring is still a reliable method of monitoring depth of anesthesia when ETAG is not used. Additionally, BIS may be most beneficial when other anesthetic medications are added, inhalational agents are excluded such in total intravenous anesthetics (TIVA), or in cases when patients may benefit from less inhalational anesthesia.[26,40]

Nasogastric tube

Nasogastric (NG) and orogastric tubes have been utilized for over 300 years as a technique to evacuate the stomach.[23] The decline in mortality following this practice lead to its use as a major advancement in surgical care during the 20th century and was soon adopted for most gastric operations.[42] Although this technique can be used therapeutically as well as for diagnostic purposes, the prophylactic use of gastric tubes following abdominal surgery has

evolved. Described in the late 1980's as "routine care"[43] and then in the mid 1990's as a "standard of care"[44], prophylactic nasogastric tube (NGT) placement has now become recommended only for selective use.[41,42,45,46]

Guidelines published by ERAS recommend NGT be removed prior to reversal of anesthesia.[6] Conclusions from a Cochrane meta-analysis found that routine use of NG decompression did not decrease the chance of pulmonary aspiration or pneumonia, did not speed the time to return of bowel function or to discharge, nor was a difference in frequency in anastomotic leaks.[41] A retrospective cohort study including 1067 patients specifically undergoing gastric bypass showed no difference in complication rate with our without a NGT.[42]

Previous expectations for routine use of NGT were to accelerate bowel function return, avoid potential pulmonary complications and anastomotic leaks, as well as decrease hospital length of stay. Prophylactic NG decompression has been repeatedly proven to not accomplish these goals.[41,42,45] Decision for insertion of NGT should be made on a case by case basis, as it may be helpful with patients experiencing nausea or distention and the effectiveness in bariatric specific ERAS protocols is not well defined at this time.[28,45] Furthermore, it is important to remove gastric tubes and esophageal or nasopharyngeal temperature probes prior to stapeling.[47]

Oxygenation

Obesity is associated with an increased risk of decreased functional residual capacity (FRC), increased closing capacity, Pickwickian syndrome, and obstructive sleep apnea (OSA) by 12-30 fold.[32,48] Surgery and general anesthesia also largely impact respiratory physiology, when combined with narcotics, obesity, and its associated complications, the additive effects can lead to respiratory depression and postoperative hypoxemia.[49]

The ERAS society recommends supplemental oxygen prophylactically in head-elevated or semi-sitting position for obese patients without obstructive sleep apnea (OSA) in the immediate post-operative period.[6] Recommendations were that the same precautions be taken in patients with OSA while also being diligent for apneic episodes and initiating positive pressure support if signs of respiratory distress appear.[6] References for these recommendations came from a small study by Eichenberger et al.,[50] which included 20 morbidly obese (MO) patients and 10 nonobese patients undergoing laparoscopic surgery. This study found that morbidly obese patients demonstrated significantly more atelectasis before induction, after tracheal intubation, and 24 hours following general anesthesia. Specifically finding that at 24 hours post general anesthetic, MO patients had an average of 9.7% atelectatic total lung area, whereas the nonobese group showed almost complete resolution at 1.9%.[50] Use of supplemental oxygen should be used immediately following tracheal extubation with the duration of its use individualized.[6] Reference to a study by Fleischmann and colleagues[51] evaluated subcutaneous wound tissue oxygenation in 20 patients with a BMI > 40 kg/m^2 compared to 15 patients with a BMI < 30 kg/m^2, showing that obese patients required a mean FiO2 of 51% compared to just 40% in the nonobese group to reach the same arterial oxygen tension of 150mmHg. Wong et al.,[49] utilized PaO2/FiO2 (PF) ratio to determine if improved oxygenation was from increased FiO2 or improved lung volume and less shunting. Results showed a significantly higher PF ratio in patients that received CPAP at 15L/min immediately following tracheal extubation compared with those that immediately received venturi mask with FiO2 of 0.40. All participants wore their respective devices for one-hour post operation as long as SpO2>/=92%. At one hour the PF ratio was significantly higher in the CPAP group and similar at two hours post operation, thus supporting the use of CPAP immediately following tracheal extubation.[49]

Guidelines by ERAS state that positive pressure ventilation should be used promptly if any sign of insufficient ventilation develops.[6] This statement is widely supported by other studies as vigilance to respiratory compromise and continuous positive airway pressure (CPAP) administration is indicated in this patient population.[49,52] HOB elevation or semi-sitting position is supported, as a decrease in FRC in the supine position is well known and placing a patient with HOB elevated increases FRC and decreases work of breathing, optimizing oxygen administration.[32]

Ventilation strategies

Difficulties with mechanical ventilation may occur during general anesthesia due to pathophysiological changes that occur in the obese patient. Optimal ventilation results in adequate gas exchange and pulmonary mechanics while minimizing risks of pulmonary complications.[53]

Strong recommendations were made in the ERAS guidelines to adopt lung protective ventilation for bariatric surgeries.[6] This suggestion comes from the results of a systematic review of 505 obese surgical patients comparing volume-controlled ventilation with pressure-controlled ventilation. Though no mode of ventilation showed benefit over the other, evidence did show that recruitment maneuvers combined with PEEP improved intraoperative PaO2/FiO2 ratio compared to PEEP alone. Levels of PEEP used were 5 to 10 cmH20 and recruitment maneuvers varied widely with inspiratory pressure from 40 to 55 cmH20 for 10 to 40 seconds, as well as a progressive or sudden increase of PEEP ranging anywhere from 5 to 30 cmH20 for 2 minutes.[53] These findings are further supported by a literature review of 13 RCTs including 8 different ventilation maneuvers of obese patients undergoing bariatric surgery.[54] Currently an international RCT, the PROBESE trial, is comparing the effects protective low tidal volume ventilation with

and without lung recruitment maneuvers to assess the occurrence of postoperative pulmonary complications. All patients will receive a tidal volume of 7 mL/kg of predicted body weight. Randomly assigned groups will either receive a PEEP of 12 cmH20 with lung recruitment maneuvers that involve a high PEEP or receive a PEEP of 4cmH20 without lung recruitment maneuvers.[55] Results have not been published at this time.

The ERAS guidelines advise that obese patients diagnosed with OSA and using home CPAP therapy should use their equipment in the immediate postoperative period. They also acknowledge, based on findings from retrospective studies, that CPAP values may need to be increased during this time due to residual effects of narcotics.[6] Recommendations for patients with Obesity Hypoventilation Syndrome (OHS), also known as Pickwickian syndrome, include placing the patient in sitting or semi-sitting position with prophylactic BiPAP/noninvasive ventilation (NIV) and intensive care level monitoring for the first 24 hours.[6] Support for this recommendation was from a dated article published in 1995 that stated the use of BiPAP or NIV for 24 to 48 hours postoperatively showed a decrease risk of respiratory complications in this patient populatin.[56] Contrary to these recommendations, the clinical practice guideline from the American Thoracic Society approved in May 2019 advises CPAP rather than NIV as the first-line treatment for patients with OHS and severe OSA. Although the American Thoracic Society states that this is a conditional recommendation, 70% or more patients with OHS also have severe OSA, thus this recommendation is made as it may apply to the majority of patients with OHS.[57]

Intravenous fluids

Intravenous fluid (IVF) administration and management is an important component to the intraoperative period and can influence short- and long-term outcomes. Most studies on IVF

administration during the intraoperative period focus on restrictive vs liberal IVF amounts, inconsistent fluid volumes have been shown throughout studies as well as varying results, as some advocate for conservative and other liberal IVF administration.[58] Attention must also be paid to the increase in total and lean body weight as well as total blood volume increase in obese patients, considering that with this increase, blood and total body water volume to total body weight is reduced compared to the non-obese population.[6,58]

The ERAS guidelines recommend using functional parameters, such as stroke volume variation (SVV) to facilitate goal-directed fluid therapy and avoid intraoperative hypotension and excessive fluid administration.[6] No precise intravenous fluid (IVF) recommendation is made by ERAS, rather they support evidence showing that excessive intraoperative fluids are not needed to prevent rhabdomyolysis and to maintain urine output (UOP).[6] Guidelines published by ERAS did review two studies that supported liberal IVF administration; both concluding that when up to 4-5 liters (L) of crystalloid was delivered during a 2-3 hour operation, occurrence of rhabdomyolysis was reduced[59] and incidence of acute renal failure was reduced.[60] However, current published guidelines from the ERAS society also discuss multiple RCT on non-obese patients that show inferior outcomes in groups that received excessive fluids compared to those that fluid balance rather was the main goal.[61,62] These recommendations are supported by two additional studies published around the same time that showed no difference in occurrence of postoperative rhabdomyolysis when 15 mL/kg IVF was used as opposed to 40 mL/kg[63] as well as no change in UOP when comparing 4 mL/kg/hour to 10 mL/kg/hour.[64] O'Neill T et al.,[65] found that intraoperative UOP was low regardless of the amount of fluid administered even when high-volume fluid therapy was used, suggesting UOP should not guide fluid therapy

administration. Rather, use of functional parameters, such as SVV-guided intraoperative fluid therapy is recommended.[6]

Functional parameters such as SVV or pulse pressure variation (PPV), have shown to be a more accurate predictor of a patient's volume status when compared to blood pressure and central venous pressure.[66] Reference to a study including 50 morbidly obese patients undergoing bariatric surgery in which SVV was used to guide intraoperative fluid administration supported this recommendation. The average amount of fluid infused for all cases was 1,989.90 mL with an average surgery length of 206.94 minutes (+/- 50.30). Results from the study showed that the initial CVP reading was the only time that it correlated with SVV throughout the case, all hemodynamic parameters were maintained within 10% of the patients baseline and renal and metabolic indicators remained within normal limits during hospitalization.[66] When comparing the fluid volume used in this study with fluid volumes from previously discussed studies, it supports use of a more restrictive fluid replacement method.

Postoperative analgesia

Obese patients may be more susceptible to postoperative hypoxic episodes due to the possibility of an already compromised respiratory system with obstructive sleep apnea, decreased functional residual capacity or decreased compliance of their lungs.[67] Use of multimodal medications to decrease or eliminate the use of opioids can be beneficial in this population as fewer complications may occur and could lead to faster recovery.[68] A multimodal approach to anesthesia is a method of achieving an acceptable level of analgesia in patients by the additive or synergistic effects of using two or more, non-opioid, analgesic medications.[69]

The ERAS society guidelines recommend a combination of systemic multimodal medications with infiltration of local anesthetic techniques be used when possible to decrease

opioid consumption.[6] No exact drug regimen or anesthetic technique has been developed for bariatric surgeries, as there continues to be lack of anesthetic guidance for pharmacological management in the obese population.[27] Instead, it is crucial that anesthesia providers understand the effects of each medication in the body and proper dosing. Guidelines from ERAS suggests using non-opioid analgesics such as acetaminophen and non-steroidal anti-inflammatory (NSAIDS) intravenously.[6] Support for this recommendation comes from a systematic review including 60 RCTs that showed favor in reduction of patient controlled analgesia (PCA) morphine consumption up to 24 hours post operation when acetaminophen, NSAIDS, and COX-2 inhibitors were used.[70] Erdogan Kayhan et al.[71] supports the use of acetaminophen and NSAIDS with an RCT, including patients undergoing laparoscopic sleeve gastrectomy or laparoscopic Roux-en-Y gastric bypass surgery that received either IV ibuprofen or IV acetaminophen for postoperative multimodal pain management. Results showed no significant difference in morphine consumption between the two groups, but did show a reduction in the pain severity score when NSAIDS were used.[71] ERAS mentions additional multimodal medications such as pregabalin and dexmedetomidine but does not specifically recommend its use due to lack of evidence of its efficacy.[6] Use of multimodal analgesia provides better postoperative pain control, shorter time in PACU, decreased opioid requirement resulting in decreased incidence of PONV, earlier oral intake and ambulation, and shorter hospital stays[68]

Recommendations from ERAS were made for the use of local infiltration techniques in addition to a multimodal regimen,[6] although shown to be a successful analgesic plan in other surgeries,[72] no specific studies including its use in bariatric surgery could be found.

The ERAS guidelines also recommend postoperative analgesia to include consideration of thoracic epidural analgesia in laparotomy. This is directed as a consideration and not a

recommendation, as there is no consensus for laparoscopic surgery.[6] Current research on use of thoracic epidural analgesia for bariatric surgery is lacking. The most recent reference discussed by ERAS, a 2011 RCT of epidural, spinal or patient-controlled analgesia for patients undergoing laparoscopic colorectal surgery, implied that use of thoracic epidural did not improve the outcome of the patient nor minimize pulmonary complications.[73]

Discussion

Implications and recommendations for practice

Review of the current ERAS protocols for bariatric surgeries followed by analysis of the current anesthesia protocol used at a midwestern medical center have shown many similarities as well as some differences. Similar to ERAS, the midwestern medical centers protocol includes administration of 8mg of dexamethasone intravenously (IV). Unlike ERAS, this protocol recommends administering the medication during or following induction, not 90 minutes prior to induction. Of the three studies cited by ERAS for this recommendation, not one recommended 90 minutes prior to induction as being superior for time of administration. The midwestern medical centers protocol recommendation is supported by the 2014 consensus guidelines for management of PONV which accepts 8mg as an optimal dose and recommends administering the medication at time of induction.[12] The protocol used by the midwestern medical center lists specific antiemetic medications to be given including emend 40mg orally upon arrival, famotidine 20mg IV preoperatively and ondansetron 4mg IV intraoperatively during closure or emergence. Though ERAS does not list specific medications, they do suggest using a multimodal approach to PONV prophylaxis and provide specific drug classifications to be used. Each drug recommended by the midwestern hospital is included in the drug classifications listed by ERAS. Utilization of these specific medications can again be supported by the consensus guidelines for

PONV which showed a decreased risk of PONV from 52% with no antiemetics to 22% with three antiemetics.[12] Additional use of haloperidol could be a consideration for use by the midwestern medical center as it has shown to have larger effects when used in combination with ondansetron and dexamethasone.[13,15,74]

The midwestern medical center protocol includes immediate availability of CMAC and use of the TROOP elevation pillow or other ramping device on all patients. As previously mentioned, studies demonstrating consistent difficult intubation in association with obesity is scarce.[24] However, anesthesia providers should always be prepared for a difficult airway and this includes patient positioning and laryngoscopy technique used.[21] Consistent with the midwestern medical centers protocol, ERAS discussed positioning the patient in the ramped position, examining a study by Collins et al.,[25] the patients in the "ramped" position were found to have a significantly improved laryngeal view compared to the "sniffing" position.

The midwestern medical center suggests the use of rocuronium and sugammedex with succinylcholine for intubation if needed. Though ERAS does not include specific neuromuscular blockers, recent findings from De Baerdemaeker et al.,[27] showed superiority in deep neuromuscular blockade for laparoscopic bariatric procedures with the use of an aminosteroid neuromuscular blocker in combination with sugammedex for reversal, supporting this suggestion by the midwestern medical centers protocol. Additionally, careful consideration for optimal location for assessing level of blockade may be important. Stimulation of the ulnar nerve resulting in contraction of the adductor pollicis muscle of the thumb is the ideal site when assessing level of blockade for recovery, as this muscle is more sensitive to effects of relaxant than the diaphragm.[26,35]

Use of PEEP, minimum 5 cmH2O, intraoperatively is recommended by the midwestern medical center. Though use of PEEP in bariatric patients is supported in research, lung protective ventilation by using recruitment maneuvers combined with PEEP have shown superiority.[53,54] A recommendation may include the addition of lung protective strategies with the addition of recruitment maneuvers with PEEP to this protocol.

The midwestern medical center recommends extubation of the endotracheal tube in the head-up position and immediate application of O2 for transport to Post anesthesia care unit (PACU). The ERAS guidelines support their protocol as they recommend supplemental oxygen prophylactically in head-elevated or semi-sitting position in the immediate post-operative period.[6] The midwestern medical center also advises that CPAP or BiPAP must be immediately available in PACU if needed. The same recommendation was made by ERRAS recommends that initiation of positive pressure support be applied if signs of respiratory distress appear.[6] Further recommendation to the midwestern protocol would be to advise all patients previously diagnosed with OSA and using home CPAP therapy to continue the use of their equipment in the immediate postoperative period, as ERAS has recommended, considering higher setting may be needed.[6]

Use of a minimum of 2 liters of crystalloid intraoperatively is included in the midwestern medical centers protocol but no recommendation on how to avoid intraoperative hypotension or excessive fluid administration. ERAS does not provide a specific IVF recommendation, their focus for IVF is on the use of functional parameters supporting evidence that shows excessive fluids in the intraoperative period are not needed to prevent rhabdomyolysis nor to maintain UOP.[6] Comparing the recommended minimum of 2 liters of IVF to one of the primary studies discussed by ERAS, the midwestern medical centers protocol supports the use of a more restrictive fluid replacement method assuming that the provider will keep IVF totals around 2

liters. Numerous studies have shown no difference in the occurrence of postoperative rhabdomyolysis or UOP with a conservative rather than liberal approach to IVF administration.[61–64]

Finally, the midwestern medical center recommends the use of a multimodal analgesic approach specifically requesting Ofirmev 1000 mg IV be given preoperatively. Though ERAS does not provide an exact drug regimen or anesthetic technique for multimodal analgesia, they do recommend a combination of medications with infiltration of local anesthetic techniques when possible to decrease opioid consumption.[6] ERAS supports the midwestern medical centers protocol by suggesting the use of non-opioid analgesics such as acetaminophen along with but IV NSAIDS.[6] Though many other multimodal medications are available, additional studies showing support for its benefits need to be conducted.

Conclusion

The purpose of this integrative review was to review and combine current ERAS protocols for bariatric surgeries and suggest system modifications to the current protocol used at a midwestern medical center. The appraisal focused on guidelines that specifically involve anesthesia providers management not only during the intraoperative phase, but also pre- and postoperatively for patients undergoing bariatric surgeries.

The ERAS society guidelines are based on good-quality RCTs, prospective cohort studies or meta-analyses of good-quality trials. Literature between January 1966 and January 2015 was searched for the consensus of these guidelines. Possible exceptions to ERAS guidelines are that some components are concluded from non-bariatric patients and largely from colorectal procedures as well as the dated references for some of their recommendations.[6]

The protocol used by the midwestern medical center follows ERAS guidelines closely and in some areas are more specific, but with certain differences as well. Particularly both guidelines agree on the use of certain antiemetics and support the use of multimodal analgesics. Concurrence is shown between both guidelines for ramped positioning of the patient for intubation, use of CMAC, and head-up position with immediate application of oxygen following extubation. Both guidelines support the use of CPAP or BiPAP for specific situations and/or patients. Though both agree that neuromuscular blockers should be used with a full reversal at conclusion of the case, ERAS does not discuss specific NMB medications while the midwestern hospital recommends Rocuronium with Succinylcholine if needed for intubation. Both guidelines support the use of sugammadex for bariatric surgeries specifically. Guidelines published by ERAS are more specific with their widely supported recommendations in lung protective strategies recommending recruitment maneuvers be used in combination with PEEP, whereas the Midwestern medical center vaguely recommends the use of a minimum of 5 cmH2O of PEEP during the case. One major difference in the guidelines was IVF management. The midwestern medical center suggested a minimum of 2 liters of crystalloid be given intraoperatively. ERAS did not provide specific IVF recommendations, rather focused their recommendation on use of functional parameters such as SVV to facilitate goal-directed fluid therapy during the intraoperative phase.

In conclusion, recommendations for the midwestern medical center would be to include the use of lung protective strategies by including recruitment maneuvers in combination with PEEP intraoperatively. Furthermore, instead of having CPAP or BiPAP immediate available if needed in the postoperative phase, another recommendation would be using CPAP or the patient's equipment in the immediate postoperative period for bariatric patients diagnosed with

OSA and using home CPAP therapy or those with OHS. Finally, I would recommend considering the addition of utilizing a functional parameter such as SVV to facilitate a more goal-directed fluid management intraoperatively.

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