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A Mini-Review of Enhanced Recovery After Surgery (ERAS®) & Enhanced Recovery After Thoracic Surgery Protocols (ERATS)

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Abstract

Enhanced recovery after surgery protocols (ERAS®) have become increasingly popular in the past few decades. Initially instituted by colorectal and gynecologic surgery, these optimized "fast track" pathways have expanded across surgical sub-specialties. We discuss critical components of such pathways, the implementation process, and particular facets of perioperative care that apply to various surgical subspecialties including cardiac, colorectal, gynecologic, and thoracic surgery. The spirit of ERAS® emphasizes a continuous internal auditing process. ERAS® protocols are known for faster recovery, shorter length of stay, improved pain control, and optimization of a patient's perioperative course by way of a standardized protocol. The unique aspects of enhanced recovery after thoracic surgery (ERATS) protocols are discussed. We focus on intercostal nerve blocks as an important component of ERATS pathways and optimized postoperative pain control. Intercostal nerve blocks in thoracic surgery allow for excellent postoperative pain control, which is critical for early ambulation, improved chest physiotherapy and easier progression through the post-operative course. This mini-review serves to highlight key features of ERAS®, salient aspects of niche surgical specialties, and focuses on thoracic surgery enhanced recovery protocols and intercostal nerve blocks in the context of ERATS for optimized postoperative pain control.

Enhanced Recovery After Surgery (ERAS®)

Enhanced Recovery After Surgery (ERAS®) protocols were originally developed for gynecologic and colorectal surgery to streamline and optimize pre-, peri-, and post-operative patient care in the 1990s. The goal is to maintain a state of normal physiology during the catabolic stress of a surgical procedure[1,2]. ERAS® has since been adopted by a variety of other surgical sub-specialties. Key features of contemporary ERAS® protocols highlight a multidisciplinary approach and note similar implementation schemes, which include designating a program coordinator, gathering key stakeholders, and establishing critical features of an enhanced recovery program[3]. The overarching goals of ERAS® are: to establish uniform care protocols, to achieve predictable outcomes with the lowest possible rate of postoperative complications, and to achieve the shortest possible length of hospital stay with the highest possible patient satisfaction and ultimately the lowest cost to healthcare systems.

The ERAS® of cardiac, thoracic, gynecology and colorectal surgery generally includes 15-25 pre-, peri-, and post-operative components. Preoperative care includes pre-habilitation, avoidance of prolonged fasting by implementing a carbohydrate loading practice, pre-operative prophylactic non-opioid analgesics, and intensive counseling in clinic. Standardized principles of intra-operative

management include a judicious use of intravenous fluid to maintain a euvolemic state, a lung protective ventilation strategy, normothermia, minimally invasive surgical techniques if possible, and use of regional anesthetics (inter-fascial nerve or intercostal nerve blocks) as applicable. Finally, post-operative care includes early mobilization, timely removal of drains and urinary catheters, resumption of diet as tolerated, and limited fluid administration. With regards to pain management, ERAS® protocols emphasize the use of multimodal analgesia and avoidance of opioids. Enhanced recovery protocols have enjoyed success when implemented well, with faster recovery, decreased length of stay and post-operative pain, and cost savings with no increased morbidity or mortality.

With regard to cardiac surgery, the following recommendations have been established: use of tranexamic acid or epsilon aminocaproic acid for on-pump cardiac procedures, sternal wound closure optimization with rigid sternal fixation (possible rigid plate fixation), avoidance of "stripping" chest tubes and maintenance of chest tube patency[4-7]. ERAS for cardiac surgery also highlights the above principles shared across specialties.

For thoracic surgery, similar principles apply. Chest tubes are removed once air leaks have resolved and output is not sanguineous; the exact amount of drainage per 24 hours that triggers removal varies by institution (for instance, at our institution, when output is less than 5ml/kg/day i.e. up to 400 ml for an 80-kg, individual chest tubes are removed)[8]. Post-operatively, patients are advanced to regular diets and have bladder catheters removed on postoperative day 1 with very low (<5%) incidence of urinary retention that require intervention[9]. Utilization of intercostal nerve blocks and infiltration of surgical wounds are described separately in this manuscript.

In colorectal surgery, the preoperative use of Entereg (Alvimopan; Adolor Corporation, Lexington, MA) is institution-dependent for prevention of prolonged ileus[9]. In addition, the field advocates an avoidance of naso-gastric tubes postoperatively and avoidance of peritoneal drains if possible. Patients should be advanced to a clear liquid diet early[10]. In gynecologic surgery, similar principles to colorectal surgery apply. ERAS® gynecologic protocols emphasize judicious use of naso-gastric tubes and early peritoneal drain removal; they also employ the use of transverse abdominis plane (TAP) blocks or paracervical nerve blocks versus intrathecal morphine depending on the nature of the surgical procedure[11]. Colorectal and GYN protocols also adhere to the aforementioned principles for pre-peri-and post-operative care. Finally, a salient highlight in the spirit of ERAS® is continuous internal-auditing and monitoring of outcomes in order to evaluate and continue to improve the ERAS® process[12].

It is important to keep in mind the guideline-like nature of ERAS® as a concept and the unique needs of an individual institution. Each hospital system has niche communities and patient populations that they serve, who may benefit from distinct aspects of ERAS®. ERAS®, while helpful in creating a framework for standardized protocols that allow for streamlined care, is ultimately a flexible system and should be used to guide hospital systems based on individual institutional resources and population needs.

Enhanced Recovery After Thoracic Surgery (ERATS)

Acute post-operative pain is intrinsic to thoracic surgery, particularly for thoracotomies. Thoracotomy approaches include muscle splitting or sparing of the serratus anterior and latissimus dorsi[13]. These incisions are associated with frequent postoperative pain and persistent opioid use. Historically, thoracic surgical patients were managed with thoracic epidural analgesia (TEA) and a reliance on both extensive opioid use and a dependence on the regional pain service for pain management. Highlights of traditional ERATS protocols, from a pain perspective, include preoperative acetaminophen and gabapentin, use of minimally invasive surgery (MIS) including robotic- and video-assisted thoracoscopic surgery, and a focus on multimodal analgesia after surgery. In particular, MIS surgery is associated with fewer complications, shorter length of stay, and decreased postoperative pain[14].

Notably, the implementation of ERATS is safe, with no increase in post-operative complications, and has been associated with shorter hospital length of stay, an important consideration in an era of cost-conscious medicine[15]. ERATS is beneficial for elderly patients, over the age of 75 years, as well as younger patients and length of stay is similar regardless of age[16]. The adoption of a standardized ERATS pathway may also allow optimized patients to be safely discharged in the context of an 23-hour enhanced recovery pathway[17].

Pain control is a specific focus of ERATS protocols, as well-controlled pain allows for improved early mobility and improved chest physiotherapy, which is particularly important after thoracic surgery. The traditional use of TEA limited patients' ability to progress through their post-operative course effectively given the neurologic, gastrointestinal, and pulmonary side effects of opioid use as well as complications associated with epidural use. From a historical perspective, although ERATS became popular in the early 2000s, expedited or "fast track" thoracic protocols have been implemented by thoracic surgeons since the 1980s and 1990s in order to provide more optimized care for patients[18]. These pathways have since transitioned into ERATS practices in the modern era. The goals of such pathways include earlier safe discharge,

fewer complications, effective pain control, decreased perioperative opioid use, and cost effectiveness. Effective ERATS programs highlight facets of postoperative care including early bladder catheter removal, early chest tube removal, ambulation and transition to regular diet[15,19].

Creating a standardized ERATS protocol within a hospital system requires "buy-in" from groups including surgeons, anesthesia providers, pharmacists, nurses, and hospital administration. When successfully implemented, patients often benefit from decreased hospital length of stay and institutions benefit financially from cost savings. Gonzalez and colleagues note average total hospitalization costs that are significantly lower (€15,945 vs €20,360, p<0.0001) after implementation of an ERATS program, with a €3,686 cost savings per patient[20]. Similarly, Paci and colleagues evaluated patients who underwent elective lung resections in an enhanced recovery pathway as compared to conventional care and found the former group had lower institutional (CAN $2,600), healthcare (CAN $2,850) and societal (CAN $4,400, statistically significant) costs[21].

Intercostal Nerve Blocks (ICNB)

Our practice implemented an ERATS protocol in February 2018, with a program that was well established by July 2018. As is the nature of ERATS, we continue to modify our protocol, institute changes, and measure outcomes (complications, pain, opioid use) as time progresses[22-24]. Inherent to the nature of thoracic surgery, intercostal nerve blocks have been instituted within the context of ERATS protocols for optimized postoperative pain control. A variety of techniques have been described. Mehran and colleagues describe a posterior transcutaneous nerve block, performed under direct visualization and recommend a wide local nerve block[25]. In our institution, we utilize a transpleural technique for our robotic-assisted thoracoscopic procedures, in which the anterior arm of the robot and a 25-gauge butterfly needle are used to infiltrate local anesthetic into 9 intercostal spaces from the 2nd to the 10th intercostal spaces under direct visualization. Intercostal nerve blocks should be combined with a diluent in order to increase the volume of anesthetic that can be safely used and to expand the surface area and length of interaction of the intercostal nerve end with the medication[25]. The timing of intercostal nerve block administration can also vary, depending on the nature of the local anesthetic utilized. Martin and colleagues administer their nerve block prior to incision or port placement[25]. Our institution prefers to administer ICNBs upon entrance into the thoracic cavity and after port placement in order to allow long-acting analgesics to take effect by the time of procedure completion. Dominguez and colleagues note they administer their ICNB at the end of the case prior to chest tube insertion[26].

Variations in local anesthetic and ICNB technique have been described, however with minimal consistency and varying use of ERATS protocols in small retrospective comparative analysis studies[22]. The use of liposomal bupivacaine (Exparel) vs. bupivacaine/epinephrine for intercostal nerve blocks has been previously described; in brief, Exparel is a longer-acting agent with a longer time to onset as compared with bupivacaine/epinephrine, which has a intermediate length of analgesic time[27]. Pain scores and morphine milligram equivalents (MME) have been used to evaluate efficacy of these local analgesics. In the multiple iterations of our ERATS program at the University of Miami, we transitioned from implementation of intercostal nerve blocks with liposomal bupivacaine to safely using a combination of bupivacaine/epinephrine as a diluent for liposomal bupivacaine with improved pain scores and decreased opioid utilization. We continue to evaluate our outcomes and perform a granular analysis of schedule II, schedule IV, and total opioid use in the context of our ERATS modifications.

Concluding Remarks

In an effort to create streamlined effective peri-operative care pathways, ERAS® and ERATS protocols have optimized patient care and allowed for improved patient outcomes across surgical subspecialties. A focus on a standardized protocol safely allows patients to progress more efficiently along their post-operative course. With respect to thoracic surgical protocols, the niche implementation and consistent use of intercostal nerve blocks allows for a focus on pain control that diminishes the role of opioids and thoracic epidural analgesia in a patient's post-operative course. In turn, with enhanced pain control, patients can recover more quickly, ambulate, and have improved pulmonary function without the associated side effects and risks of opioid use. Our institution has carefully monitored the progression and changes we have made to our ERATS protocol in order to monitor our total and schedule II opioid use, pain scores, and complications. In looking to the future, we aim for schedule II-free opioid use and continue to use a combination of intermediate-acting bupivacaine/epinephrine and long-acting Exparel in our ICNBs for optimized pain control as a critical component of our ERATS protocol.

Conflict of Interest

The authors have no conflicts of interest to declare.

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