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Perioperative Hemodynamic Monitoring Through Collaborative Approaches Among Surgeons and Anaesthetists to Minimize Surgical Complications in Thoracic Surgery

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Abstract

Background: Perioperative hemodynamic monitoring is crucial in reducing surgical complications, particularly in thoracic surgery where collaboration among surgeons, anesthesiologists, and other specialists is essential. Effective management during the perioperative period can significantly impact patient outcomes.

Methods: This narrative review synthesizes recent advancements in perioperative management, focusing on collaborative approaches between surgical and anesthetic teams. Key areas examined include double-lumen tube (DLT) intubation techniques, postoperative pain management strategies, delirium prevention, and the formation of cohesive perioperative teams.

Results: Innovations in DLT intubation, including the use of video-assisted laryngoscopes, have improved success rates and minimized airway injuries. The review highlights the importance of multimodal analgesia techniques, such as epidural analgesia and regional nerve blocks, in enhancing postoperative recovery and reducing complications. Emphasis is placed on Enhanced Recovery After Surgery (ERAS) protocols, which advocate for early mobilization and efficient pain management to optimize patient recovery.

Conclusion: A multidisciplinary approach to perioperative care, integrating advanced monitoring techniques and collaborative strategies, is vital for improving outcomes in thoracic surgery. Continued research and implementation of best practices are essential for enhancing patient safety and recovery.

Keywords: Perioperative management, thoracic surgery, double-lumen tube, Enhanced Recovery After Surgery (ERAS), multimodal analgesia.

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1. Introduction

Respiratory surgery is intricate and necessitates a cooperative strategy comprising the surgeon, anesthesiologist, pulmonologist, and more experts. They must collaboratively ascertain the optimal

therapy considering the patient's condition, underlying health concerns, and risk evaluation [1,2]. A comprehensive preoperative assessment must include a complete physical examination and a review of characteristics such as exercise ability, comorbidities, and lifestyle habits, including smoking and alcohol intake [3]. Furthermore, the kind and magnitude of the operation must be evaluated to reconcile the patient's perioperative risks with long-term pulmonary results. Essential elements for guaranteeing appropriate patient care include preoperative assessment, intraoperative anesthetic administration, postoperative analgesia management, and the incorporation of accelerated recovery after surgery (ERAS) procedures for pulmonary resections. Thoracic surgery, a subset of chest surgery, often entails interventions next to vital blood arteries, including the superior and inferior vena cava, pulmonary artery, and aorta, requiring meticulous perioperative management [4,5]. Effective pain management is essential for boosting postoperative comfort, minimizing complications, and improving overall quality of life [6]. Timely and efficient pain management using many methodologies may mitigate the onset of chronic pain syndromes, which may adversely affect a patient's daily functioning [7].

Moreover, the COVID-19 pandemic results in significant bronchopulmonary consequences and the appearance of atypical causal agents, including viral pneumonia. Moreover, the conventional approaches, as specified in established procedures, demonstrated limited effectiveness in several scenarios [8]. Moreover, the dissemination of microorganisms categorized as nosocomial infections resulted in extensive contamination, including the penetration of surgical instruments. Given that lung surgery is significantly impacted by such infections, it may be prudent to reassess the innovative procedures and methodologies for respiratory surgery.

This narrative review examines recent advancements in perioperative management, encompassing techniques for double-lumen tube (DLT) intubation and extubation, the critical significance of postoperative pain management about Enhanced Recovery After Surgery (ERAS), strategies for delirium prevention to facilitate ERAS, and (4) the necessity of establishing a robust perioperative team for respiratory surgery.

2. Reducing the Invasiveness of Double-Lumen Tube Intubation and Extubation: Innovations in Technique and Airway Management

Typically, thoracic procedures, particularly video-assisted thoracoscopic surgery, need a fully deflated lung to enhance the visibility of the operating area. This objective may be accomplished with one-lung ventilation (OLV), a method that facilitates breathing in one lung while the other remains deflated. It is the most often used apparatus for delivering separate breathing to each lung. The OLV approach facilitates the mechanical separation of the lungs, enabling ventilation of just one lung while the other passively deflates or is repositioned by the surgeon to enhance visibility during non-cardiac thoracic operations, including esophageal, aortic, or spinal procedures [9]. The predominant ventilation techniques for one-lung ventilation (OLV) are double-lumen tubes (DLT) and bronchial blockers (BB) [10]. DLT is recommended for its rapid insertion, straightforward deflation and suction capabilities from the isolated lung, and adaptable use of continuous positive airway pressure [11]. BB, conversely, inflicts less damage to the trachea, likely because of its reduced diameter and decreased intra-tracheal pressure, hence obviating the need for tracheal tube replacement to sustain postoperative mechanical breathing after surgery [12]. Currently, the selection of DLT or BB often relies on the preferences of the surgeon or anesthesiologist. Nonetheless, an unresolved inquiry persists about the appropriate airway device for executing one-lung ventilation (OLV).

A thorough review and meta-analysis have shown that DLT is more expedient to insert and less prone to misplacement compared to BB [13]. Nevertheless, findings indicated reduced airway damage with the use of BB in comparison to DLT [14]. Recent research indicates that BB application correlates with increased severity of lung infiltration (particularly on the surgical side) and a greater rate of ICU admissions during the early postoperative phase, potentially impacting the patient's first recovery [15]. Conversely, findings indicate that postoperative hoarseness remained unchanged between DLT and BB [16]. Although the

impact of BB on patients' postoperative recovery requires more research, DLT intubation, characterized by low invasiveness, may provide superior airway results.

DLTs are used in minimally invasive cardiac procedures and cases involving one lung, aiding in the prevention of contamination from the contralateral lung. Furthermore, DLTs facilitate bronchial clearance without disrupting breathing. In contrast to single-lumen tubes, double-lumen tubes (DLTs) are bigger, longer, and more intricate, making their application more intrusive, particularly in patients requiring mechanical ventilation [17]. Accurate vision of the glottis is crucial during intubation to mitigate stress to the upper airway and decrease intubation duration.

DLTs are now the benchmark for airway management in procedures necessitating one-lung breathing. Nonetheless, effectively placing these catheters may be difficult, even for seasoned anesthesiologists [18]. The elevated failure rate may be ascribed to several reasons, including the design of the DLT, the operator's expertise, and anatomical discrepancies among patients. The DLT's double-barrel construction enhances its exterior diameter and diminishes its flexibility relative to a comparably sized single-lumen tube, hence complicating intubation, particularly in patients with atypical airway anatomies.

Recently, video-assisted laryngoscopes have been created to enhance the efficacy of intubations in both standard and challenging airways [19,20]. The McGRATH® MAC (McG) gadget is equipped with a high-resolution video camera that offers both direct and indirect views of the glottis, making it especially effective for challenging airways. The McG's blade adheres to the conventional Macintosh curve, possibly mitigating difficulties in DLT intubation while providing the advantages of video laryngoscopy. Anesthesiologists may maneuver the DLT by both direct and indirect viewing techniques. Prior research indicated that the McG exhibited a superior success rate for intubation and decreased intubation durations relative to the traditional Macintosh laryngoscope (McL) [21]. Furthermore, the Cormack grade and POGO score showed considerable improvement in McG trials, indicating increased laryngeal vision. Moreover, McG's diminutive blade, in contrast to other video laryngoscopes, may alleviate the challenges associated with tube handling and insertion. Significantly, patients in the McG trials had less hoarseness and pharyngeal discomfort compared to those in the McL trials, indicating that DLT intubation may be conducted with less invasiveness with the McG.

Meticulous and cautious extubation of the double-lumen tube is crucial for airway and circulatory management, especially after lung resection, as it mitigates the risk of complications such as bucking or pneumothorax [22]. The impact of the angle of DLT extraction on extubation has not been extensively investigated. Proper airway and circulatory control throughout the anesthetic recovery period is essential, as inappropriate extubation timing may result in significant problems. Premature extubation may lead to laryngospasm, airway blockage, or respiratory depression due to residual anesthetics. Conversely, postponed extubation may lead to complications such as hypertension, tachycardia, or pneumothorax resulting from repeated manual breathing. Attaining seamless and non-invasive extubation has always been a primary goal for anesthesiologists [22].

Prior research indicated that extubation at a 60° angle to the ground (forward) required less effort than at a 90° angle (vertical), corroborating results from a randomized clinical investigation on single-lumen tubes. Moreover, blood pressure variations were more pronounced during extubation at 90° than at 60°. The findings indicate that extubation at 60° is less invasive for patients [23]. Additional research on the appropriate methods for intubating and extubating double-lumen tubes is necessary.

3. Postoperative Analgesia in Thoracic Surgery: An Essential Element of Enhanced Recovery After Surgery (ERAS)

Effective postoperative pain management after thoracic surgery is crucial for facilitating a seamless recovery and minimizing complications [24]. Thoracic procedures may need extensive incisions, potentially resulting in considerable discomfort if inadequately managed. Efficient pain treatment facilitates deep breathing, hence mitigating pulmonary problems such as atelectasis and pneumonia [25].

Diverse analgesic techniques are often used in conjunction to enhance patient comfort and recovery results.

Epidural analgesia is a very successful procedure involving the insertion of a catheter in the back to provide local anesthetics or opioids. This technique enhances chest mobility, hence facilitating deep breathing and coughing, which is essential for the rehabilitation of lung function. A prevalent method entails nerve blocks, including intercostal or paravertebral blocks, which provide localized pain alleviation by anesthetizing certain nerves without impacting the full body [26,27].

Opioids, such as morphine and fentanyl, are extensively used for postoperative analgesia and may be delivered via several methods, including epidural, intravenous, or oral administration. Opioids are effective analgesics that need careful administration because of possible adverse effects such as nausea, constipation, and respiratory depression. Non-steroidal anti-inflammatory medications (NSAIDs) and acetaminophen are often used in conjunction with opioids to augment analgesia and mitigate inflammation while reducing adverse effects. NSAIDs should be used cautiously owing to the potential for gastrointestinal or renal problems.

A prevalent approach to patient autonomy in pain treatment is patient-controlled analgesia (PCA), a mechanism enabling patients to self-administer regulated amounts of analgesics, usually opioids, by pushing a button. This approach allows patients to customize their pain management according to their needs while safeguarding against overdosing via integrated safety features.

Insufficient pain management may result in many problems, such as shallow breathing, hence increasing the risk of respiratory failure and pulmonary conditions like pneumonia. It may also lead to chronic discomfort, adversely affecting the patient's quality of life. Effective pain management solutions must be tailored to the individual, including the patient's general health, kind of operation, and medical history, while balancing pain treatment with possible adverse effects [27].

Additionally, there are discussions about opioid use in postoperative pain management. Reducing opioid use during surgical procedures may enhance patient outcomes by reducing the risk of opioid-related problems postoperatively [28]. New research examined the effectiveness of opioid-free anesthesia in alleviating pain during video-assisted thoracoscopic surgery, using an analgesia index as a monitoring instrument. The results demonstrated that an opioid-free anesthetic method offered similar intraoperative pain management, as assessed by the pain threshold index, to conventional opioid-based anesthesia in this surgical procedure [29].

In recent years, several Enhanced Recovery After Surgery (ERAS) programs have developed, highlighting the need for efficient pain management and proactive rehabilitation to mitigate complications, decrease hospital durations, and minimize healthcare expenditures [30,31]. In the ERAS paradigm, postoperative pain management is essential for promoting early mobility and expediting recovery.

The efficacy of ERAS programs depends on sophisticated pain management technologies that enhance patient comfort and facilitate expedited recovery. The use of these methods in surgical treatment corresponds with the overarching objectives of improving patient outcomes and maximizing healthcare resources [32]. As evidence for ERAS expands, the emphasis on advancing postoperative pain management strategies remains crucial for attaining these objectives, safeguarding patient welfare, and optimizing healthcare efficiency.

Four. Enhancing Thoracic Surgery Results: The Significance of ERAS and Dexmedetomidine in Perioperative Management

ERAS aims to diminish surgical complications, decrease hospital durations, and enhance total organ functionality via the use of evidence-based patient care guidelines [33,34]. These recommendations include all stages, from preadmission to postoperative care, to enhance results. The guidelines, supported by the Enhanced Recovery After Surgery Society and the European Society for Thoracic Surgery, encompass preoperative counseling, nutritional assessment, smoking cessation, avoidance of extended

fasting, utilization of preoperative carbohydrate beverages, reduction of preoperative sedatives, administration of venous thromboembolism prophylaxis, prevention of hypothermia, application of short-acting anesthetics and regional anesthesia, preference for minimally invasive procedures, and promotion of early postoperative mobilization [34]. Numerous ideas derived from colorectal surgery ERAS guidelines have been effectively transferred to thoracic surgery, enhancing patient satisfaction and results in this domain.

A major problem in thoracic surgery is the management of postoperative delirium, characterized by impairments in awareness, cognition, perception, and attention, as well as changes in sleep and circadian rhythms [35,36]. Delirium in the perioperative phase might result in additional problems, extended hospitalizations, and heightened fatality rates [37]. While delirium induced by pain or other readily manageable causes may often be mitigated by environmental adjustments and supportive interventions, pinpointing its etiology during surgical procedures can be intricate. Multiple factors, including preoperative stress, surgical anxiety, strange environments, and postoperative pain, contribute to the complexity, complicating the identification of a single cause [38]. Patients undergoing thoracic surgery, especially the elderly, have an elevated risk of postoperative delirium attributable to surgical trauma, circulatory disturbances from diseases such as atrial fibrillation, and reduced oxygenation after lung resection [39].

Postoperative delirium may significantly affect the first recovery period, presenting as behaviors like restlessness, removal of intravenous lines or central venous catheters, refusal of oxygen masks, or even falls, all of which might impede recovery [40]. In many instances, pharmaceutical therapies, such as antipsychotic medicines, are necessary to address delirium; however, excessive use of these drugs may result in adverse consequences such as extrapyramidal symptoms. Consequently, preventing delirium is essential, particularly in thoracic surgery, when the removal of oxygen masks or chest drains may lead to life-threatening complications. Furthermore, excessive coughing or excitement may elevate airway pressure, possibly resulting in pneumothorax or surgical hemorrhage, necessitating careful control.

Dexmedetomidine (DEX), an alpha-2 adrenergic agonist, has become a significant asset in critical care units owing to its capacity to induce drowsiness with little respiratory depression [41,42]. It is especially beneficial in postoperative care, aiding in the reduction of supplementary analgesic requirements while preserving sedation. DEX is recognized for its efficacy in delivering superior sedation and exhibits a minimal occurrence of delirium, establishing it as a crucial choice for postoperative management. Research indicates that sustained low-dose administration of DEX in critical care environments is useful in both preventing and treating delirium [43]. The advantages of DEX—minimal respiratory depression, analgesic properties, reduced side effects such as hypotension, and its efficacy in preventing delirium—render it especially appropriate for elderly patients recuperating after thoracic surgery. The intraoperative use of DEX may be advantageous in lung resection procedures for individuals with a history of postoperative delirium or agitation upon awakening.

DEX also has several beneficial benefits in OLV. It offers drowsiness with little effect on respiratory function, making it preferable to conventional sedatives such as propofol or benzodiazepines, which may induce respiratory depression [44]. DEX facilitates the maintenance of constant oxygenation levels during one-lung ventilation, hence enhancing the safety of anesthesia. The hemodynamic-stabilizing effects, attributed to its alpha-2 agonist activity, mitigate circulatory instability, including hypotension and tachycardia, therefore enhancing patient outcomes [45]. DEX contributes to the optimization of pulmonary blood flow by diminishing circulation to the collapsed lung and enhancing oxygenation in the ventilated lung, hence increasing gas exchange during one-lung ventilation [46]. Moreover, its anti-inflammatory characteristics may reduce the likelihood of postoperative lung damage, a prevalent issue during one-lung ventilation owing to mechanical stress.As further research becomes available, a comprehensive assessment of DEX's intraoperative and postoperative use is crucial to comprehend its full potential in improving recovery for thoracic surgery patients.

4. Enhancing Perioperative Crisis Management in Thoracic Surgery with Collaborative Strategies

Training in perioperative crisis management for respiratory surgery is a complicated procedure that requires rapid decision-making and efficient coordination among medical personnel. In thoracic surgery, resuscitation attempts are hampered by the partitioning of the operation field into sterile and non-sterile zones, necessitating effective coordination. To improve situational awareness and procedure efficacy, non-technical skills such as communication within the medical team are essential [47].

Close coordination between the surgeon and the anesthesiologist is essential during regular surgeries for addressing issues such as one-lung ventilation, lung protection measures, extubation choices, and postoperative pain management. In crises such as vascular damage or life-threatening arrhythmias, the lateral decubitus posture and absence of cardiopulmonary bypass complicate resuscitation efforts. Collaborating with the clinical team enhances comprehension of individual roles and improves communication, hence promoting patient safety [48]. Alongside intra-department collaboration, inter-departmental cooperation with radiology, transfusion, and testing departments is crucial for the establishment of efficient emergency blood transfusion and testing systems. Medical workers in the operating room must recognize the need for teamwork between surgical and non-surgical staff. Anesthesiologists, often at the forefront of emergency interventions, need to engage proactively with other departments, including radiology and laboratory services, during important events such as significant bleeding. The first step in planning for perioperative crises is to promote talks among various medical departments and specializations. Discussions conducted in non-clinical settings devoid of imminent pressure facilitate consensus-building and enable effective emergency responses [49,50].

To guarantee efficient emergency response procedures in respiratory surgery, it is crucial to include the perspectives of department heads, nursing directors, as well as actively practicing physicians, nurses, and clinical engineers. Interprofessional training enhances comprehension and communication among healthcare personnel. Joint seminars with educational hospital groups facilitate the exchange of varied hospital practices and the sharing of important insights acquired via collaborative training, therefore improving mother and child healthcare safety.

The efficacy of simulation-based training in enhancing patient safety inside the operating room is well demonstrated. This training enhances both technical competencies and essential non-technical abilities, including situational awareness, collaboration, decision-making, leadership, and communication in emergency contexts [51]. From a crisis management standpoint, implementing "perioperative team" training is crucial, particularly for situations such as significant intraoperative hemorrhage or cardiac arrest. To enhance survival rates and patient outcomes, the whole perioperative team must cultivate advanced non-technical abilities, including both cognitive (decision-making and situational awareness) and interpersonal (communication and collaboration) qualities. Training in non-technical abilities is well-established in emergency care and fast response teams; nevertheless, the operating room poses distinct problems.

In the operating room, patients are under constant surveillance, and essential medical data, like weight and medical history, is easily accessible, facilitating crisis management. Furthermore, the etiology of the crisis is often evident (e.g., hypovolemia resulting from significant hemorrhage or hypoxia owing to respiratory failure). Nonetheless, a notable distinction in the operating room setting is the limitation on non-verbal communication resulting from the use of masks and goggles. Consequently, perioperative crisis management necessitates customized evaluations of non-technical skills that correspond to the particular circumstances in the operating room. Crisis management responsibilities are often allocated between people in the operating domain (e.g., surgeons, and scrub nurses) and those in the non-operative domain (e.g., anesthesiologists, circulation nurses, and medical engineers). These teams maintain their specific functions during crises, cooperating within their assigned areas. Surgeons and scrub nurses concentrate on bleeding management, whilst the non-operative team oversees resuscitation and the maintenance of vital signs. Collaboration across these teams is essential for efficient resuscitation in the

operating room, and evaluation techniques must include the unique responsibilities and interactions between operational and non-operative staff.

Integrating assessments of situational awareness and communication across these two domains will improve the efficacy of perioperative team management and resuscitation simulations. For instance, evaluations may encompass criteria such as "mutual situational awareness between operative and non-operative domains" and "efficient verbal communication among teams." Ongoing assessment of these elements will enhance the efficacy of simulation-based training for addressing intraoperative crises [52]. Simulation-based talks conducted in a problem-based learning discussion (PBLD) framework may effectively strengthen non-technical abilities [53]. Each expertise provided distinct viewpoints and interpretations of identical events and vital signs, resulting in crucial discoveries. Scenarios included the management of significant bleeding resulting from pulmonary artery damage, intraoperative hypoxemia associated with one-lung ventilation complications, and post-extubation hypoxemia. Future conversations may also include subjects such as postoperative delirium and the management of chest drains, providing further avenues for education and enhancement.

5. Conclusions

In summary, thoracic surgery requires a multidisciplinary strategy that includes surgeons, anesthesiologists, pulmonologists, and other experts to optimize patient results. The preoperative examination, including evaluations of lifestyle variables such as smoking, comorbidities, and general health, is essential for surgical planning and risk reduction. ERAS procedures, which emphasize the enhancement of intraoperative management and postoperative analgesia, are crucial for facilitating recovery and minimizing problems. DLTs are crucial for one-lung breathing in thoracic surgery, facilitating lung isolation for enhanced operative visibility. Nonetheless, DLTs may be intrusive, and innovations, such as video-assisted laryngoscopes like the McGRATH® MAC, have enhanced the safety and efficacy of DLT intubation. Moreover, appropriate extubation procedures reduce airway damage.

Effective postoperative pain management is essential for recovery, facilitating deep breathing and early mobility to avoid complications such as pneumonia. Methods like epidural analgesia, nerve blocks, and patient-controlled analgesia enhance pain treatment efficacy. DEX is notably efficient in alleviating pain and avoiding delirium, particularly in geriatric patients, owing to its calming qualities that do not induce respiratory depression. Advancements in perioperative treatment, pain control, and collaborative methods are enhancing results in thoracic surgery, leading to improved recovery and quality of care.

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مراقبة الدورة الدموية أثناء الفترة المحيطة بالجراحة من خلال التعاون بين الجراحين وأطباء التخدير لتقليل المضاعفات الجراحية في جراحة الصدر

الملخص

الخلفية:تعتبر مراقبة الدورة الدموية أثناء الفترة المحيطة بالجراحة أمرًا ضروريًا للحد من المضاعفات الجراحية، خاصة في جراحة الصدر، حيث يكون التعاون بين الجراحين وأطباء التخدير وغيرهم من المتخصصين أمرًا أساسيًا. يمكن للإدارة الفعالة خلال الفترة المحيطة بالجراحة أن تؤثر بشكل كبير على نتائج المرضى.

الطرق:تستعرض هذه المراجعة السردية التقدمات الحديثة في إدارة الفترة المحيطة بالجراحة، مع التركيز على النهج التعاونية بين الفرق الجراحية والتخديرية. تشمل المجالات الرئيسية التي تم فحصها تقنيات التنبيب باستخدام الأنبوب مزدوج التجويف (DLT) ، واستراتيجيات إدارة الألم بعد الجراحة، والوقاية من الهذيان، وتشكيل فرق متماسكة لإدارة الفترة المحيطة بالجراحة.

النتائج:أظهرت الابتكارات في تقنيات التنبيب باستخدام الأنبوب مزدوج التجويف، بما في ذلك استخدام منظار الحنجرة المدعوم بالفيديو، تحسنًا في معدلات النجاح وتقليل الإصابات الهوائية. تسلط المراجعة الضوء على أهمية تقنيات تخفيف الألم المتعددة الوسائط، مثل التخدير فوق الجافية وحجب الأعصاب الإقليمية، في تحسين التعافي بعد الجراحة وتقليل المضاعفات. يتم التأكيد على بروتوكولات التعافي المعزز بعد الجراحة (ERAS)، التي تدعو إلى التحرك المبكر وإدارة الألم بكفاءة لتحسين تعافي المرضى .

الخلاصة:إن النهج متعدد التخصصات في الرعاية المحيطة بالجراحة، الذي يدمج تقنيات المراقبة المتقدمة والاستراتيجيات التعاونية، ضروري لتحسين النتائج في جراحة الصدر. إن مواصلة البحث وتنفيذ أفضل الممارسات أمران أساسيان لتعزيز سلامة المرضى وتعافيهم.

الكلمات المفتاحية:إدارة الفترة المحيطة بالجراحة، جراحة الصدر، أنبوب مزدوج التجويف، التعافي المعزز بعد الجراحة (ERAS) ، تخفيف الألم المتعدد الوسائط.