SCIENCE AND TECHNOLOGY

Thoracic Lobectomy

KAREN ESQUIVEL
KAISER PERMANENTE
ANESTHESIA
TECHNOLOGY PROGRAM

AMANDA WITTRY
KAISER PERMANENTE
ANESTHESIA
TECHNOLOGY PROGRAM

Special thanks to the KPAT faculty, Dr. Sarah Giron, Otoniel Castillo and Sara Paraspolo, for their advice, counsel, correction, additions to, and proofreading of this Case Study.

CASE SCENARIO

A 38-year-old female weighing 185 lbs. and stands five foot five inches tall (5’5”) was admitted for thoraco-abdominal trauma, following a motorcycle crash. Although trauma rescue teams provide pre-hospital care, it is limited to basic life support (BLS) and advanced cardiac life support (ACLS) (James & Pennardt, 2022). Therefore, upon arrival to the emergency department, the medical staff began to assess the patient’s status and promptly place her on monitors– ECG, pulse oximeter, and blood pressure– to attain a baseline measure of her vital signs. The vital signs will allow the doctors to formulate a plan of treatment. Obtaining a patient’s history and physical (H&P) is essential for treatment, but it may be challenging in an unresponsive or altered patient. Therefore, a complete physical exam, imaging, and lab tests are vital to the choice of therapy. During a trauma situation, coordination is necessary. This coordination is essential to direct blood bank, lab, x-ray imaging, and respiratory therapy for each to conduct the appropriate procedures on the patient (James & Pennardt, 2022). Damage to the brain and other internal organs is possible in trauma situations, especially motor vehicle accidents. Vital signs may be of assistance in determining a patient’s relative health status, but it does not directly reflect a specific location on the body, or area of concern which could indicate the need for imaging and or lab testing. During this assessment period, a nurse inserted a 20g peripheral intravenous line (IV), this small gauge catheter is necessary for any initial administration of drugs and fluid, as well as potential blood draws. Indeed, the ER lab tech drew a blood sample to crossmatch the patient for potential transfusion, and the patient was prepared for imaging.

The patient was taken to the CT scanner which revealed a grade 4 spleen laceration with hemoperitoneum, and left hemopneumothorax along with a left lung contusion. The ER physician referred the case for surgery and called the trauma surgeon. An order for an emergency splenectomy and left chest tube insertion was communicated to the charge nurse in the operating room (OR). Traumas are most often reported directly to surgery personnel via a paging system or phone call. This allows trigger the surgical trauma team members to be activated. This will also facilitate the sharing of information about the patient's injuries. In turn, the team will prepare for the appropriate procedure(s). Since the patient is incoherent, no consent can be granted by the patient herself. The ER physician along with the trauma surgeon will fill and sign an emergency consent form. Only then can the surgical team proceed with the surgery.

Suddenly, dramatic changes are noted in the patient's hemodynamics and electrophysiology. The suspicion is hypovolemic shock.

Trauma to abdominal structures may certainly be characterized by major blood loss. Consequently, the provider proceeded to insert an additional large bore IV (18g) and ensured that banked blood units were type & crossed, and immediately available upon request. Once the patient arrives to the operating room, she is given induction medications and intubated via a rapid sequence induction (RSI). RSI was utilized because the patient's NPO status was unknown. An orogastric tube is also inserted following the induction of anesthesia to ensure the emptying of the stomach contents and deflation of any distending gasses (Gent & Blackie, 2017). The surgeon proceeds to make a midline incision by which could then remove the spleen,. This approach "is preferable as it affords excellent exposure, rapid access, and evaluation of other structures" (Gent & Blackie, 2017). As determined earlier, the patient's left lung is compromised because of to the hemopneumothorax associated with lung contusion. A chest tube was placed to drain the air and fluids that have collected in the pleural space. The chest tube was placed after the completion of the splenectomy taking advantage of the general anesthetic. The procedure can be performed in the ER. However, the trauma surgeon made a small incision on the chest, spread open the skin and muscle layers, then inserted the tube. The chest tube was secured with stitches and covered by a sterile dressing. The chest tube was connected to a negative pressure drain system which "allow[s] the air or fluid to drain on its own or [we] apply suction to draw the air or fluid out" (Batra et. al, 2020). Further imaging is needed to verify how much air or fluid was drained. Following the surgical procedures, the patient more than likely will remain intubated and transferred to the intensive care unit (ICU) for close monitoring due to the increased blood loss and compromised pulmonary function.

Once in the ICU, the patient is continually monitored. The incision and surgical site are assessed for noticeable abnormalities, medication is concurrently administered as needed to sustain sedation, and to control postoperative pain. After 4 hours in the ICU, the critical care nurses continue to monitor the patient's condition. Suddenly, dramatic changes are noted in the patient's hemodynamics and electrophysiology. The suspicion is hypovolemic shock. Often after major surgery or trauma surgery this can be common due to major blood loss. STAT imaging is ordered, the CT scans reveal an expanding left lung hematoma with hemothorax due to the contusion. The trauma surgeon and intensivist concur that an emergent posterolateral thoracotomy is necessary to relieve the issue. The patient is immediately scheduled for an emergency left lung inferior lobectomy.

A thoracic lobectomy involves the resection of thoracic tissue and potentially bone. The surgeon will use as a passage to enter the chest cavity and operate on the affected area of the lung. These procedures are expected to last approximately 3 hours. The patient is transferred to the operating room directly from the ICU with monitoring. Again, the patient remains intubated, and hand ventilated in transport.

DISCUSSION

Considering that this would be the patient's second anesthetic with a 24-hour period, further investigation by the provider is necessary. Therefore, another assessment is necessary, the anesthesia provider will read the patient's medical chart to evaluate the information and current conditions to prepare for the second round of this case. Certainly, the patient's chart will include details regarding the most recent interventions and procedures from the first arrival to the hospital up-to the patient's current condition. Since the patient's current condition is life-threatening, rapid deliberate treatment is necessary. The use of invasive monitoring is indicated. The anesthesia technologist should communicate with the provider to review any major, patient-specific concerns and prepare to assist with the patient's arrival back into the operating room.

Foremost, at the beginning of the day the anesthesia technologists' team should perform a daily room check, making sure a full oxygen tank is available along with an AmbuÒ bag, patient warming devices, and a bougie in the room. The technologist will then proceed with a full machine test, following FDA protocols, to ensure there are no circuit leaks and the machine is ready for use. During this time the technologist should make sure suction is working and the non-invasive monitors are available and ready for use; per the American Society of Anesthesiologists (ASA) guidelines, this includes ECG leads, blood pressure, pulse oximeter, temperature probe, and EtCO2.

The "advantages to double-lumen tubes are relative ease of placement, the ability to ventilate one or both lungs, and the ability to suction either lung" (Butterworth et al, 2018, p. 558).

In preparation for the case, the anesthesia technologist should set up the necessary equipment that may be needed for this case. Given that the patient is scheduled for a thoracic lobectomy, a double-lumen endotracheal tube (DLT) is necessary to facilitate a collapsed lung for maximal surgical exposure. The "advantages to double-lumen tubes are relative ease of placement, the ability to ventilate one or both lungs, and the ability to suction either lung" (Butterworth et al, 2018, p. 558). Double-lumen tubes (DLTs) are available in several sizes, measured in French sizes (FR): 35, 37, 39, and 41 FR. They can be either left or right sided. There is no specific preference when choosing either a left or right-sided DLT. Either can be used "irrespective of the operative side. However, for simplicity, many practitioners prefer to use left-sided tubes for nearly every case" (Butterworth et al, 2018, p. 558). For female patients, a size 35 or 37 FR is adequate, so both sizes should be available for use. A fiberoptic scope may be used to determine the correct placement of the DLT, therefore, it will be set up along with the difficult airway cart. Given that the patient is already intubated, an airway exchange catheter may be used and should be available. Standard airway equipment should be set up such as a size 9.0cm oropharyngeal airway (OPA), 10cc, 5 cc and 3 cc syringes to assess the distal cuffs, a nasogastric or orogastric tube should also be available to empty the stomach of any gastric secretions and a video laryngoscope blade.

The use of invasive monitoring, such as an arterial line and central venous catheter, is indicated due to the major shifts that are predictable in this patient's hemodynamics. It may also be useful to send continual arterial blood gas samples or use point of care testing to closely monitor the patient's progress. A pressure bag with 0.9% normal saline and one or two transducers will be set up and zeroed along with sterile towels, an angiocath (Arrow arterial catheterÒ are common), a guidewire, gauze, and bio-occlusive dressing. An ultrasound probe with a sterile cover should be available for use if the provider is not able to palpate the artery. Likewise, a central venous catheter kit should be set up and available for placement to treat episodes of hypovolemia or intense blood loss. The ultrasound will be used for this procedure as well. Since the central venous line will be used for rapid fluid resuscitation, a high-flow catheter should be set-up in advance. Central venous catheters come in varied sizes; a double lumen, 9 FR multi-lumen access catheter (MAC catheter), is the most adequate to accommodate high fluid rates as high as 33,000 mL/hr.

In most cases, the patient will be transferred from the ICU into the operating unit by a transporter, accompanied by a nurse and a respiratory therapist who will assist with bag mask ventilation. In other situations, the anesthesia care team may get the patient, in which case the anesthesia technologist will aid in the safe transport of the patient. During transport, the patient will be connected to a transport monitor to continuously measure vital signs. By this time, the anesthesia provider would receive a report from the ICU staff regarding medication and patient status. As the patient is transported into the operating room, the anesthesia technologist should be prepared to assist with the transfer of infusion pumps from the ICU bed onto the designated IV pole in the room. The technologist will attach the patient monitor cables to the anesthesia physiologic monitors, ensuring the collection of vital sign readings. The patient will then be transferred onto the operating table, she will be kept in the supine position, followed by a switch of ventilation from the AmbuÒ bag to the anesthesia gas machine circuit. It is important to be attentive to the chest tube during transfer to avoid any dislodgement or detachment. The chest tube drainage system should then be connected to a suction source which will remain on until the start of the procedure.

Once the patient has been positioned and safely secured, the anesthesia provider along with the surgical team will conduct a time out, confirming the patient's name and procedure. During most non -acute cases, the induction process will begin. However, since the patient is intubated with a standard endotracheal tube, the anesthesia technologist will assist the provider in exchanging the ETT for a DLT. Although the procedure is emergent, a tube exchanger is advised, given that the use of a DLT benefits procedure outcomes– the diameter is three times the external diameter of a standard ETT (Nagelhout & Elisha, 2018 p.632). Since the patient is on a continuous propofol infusion drip – a standard maintenance agent for intensive care of intubated patients – the anesthesia provider can choose to continue the infusion for the entire procedure and may administer a bolus dose if deeper anesthesia is necessary. The provider will also administer some type of muscle relaxation. In our case, Rocuronium – a non-depolarizing muscle relaxant will be used. The anesthesia care team can confirm neuromuscular blockade with the use of a nerve stimulator. Once the provider has confirmed the proper level of anesthesia and confirmed good neuromuscular blockade, the breathing circuit will be disconnected from the ETT, and an airway exchange catheter will be threaded through the ETT until the distal tip has reached the close to the carina. The distal cuff on the ETT will then be deflated, and the technologist will carefully assist in removing the tube while the provider holds the catheter in place. This must be done quickly and carefully to maintain a secure airway and adequate oxygenation. The left sided DLT will then be lubricated and threaded over the catheter. The use of a GlidescopeÒ or other video-assisted laryngoscope is ideal to provide the best view. The use of a video laryngoscope allows the provider to manipulate the oral structures and make room for the DLT as it passes through the vocal cords and into the larynx. "The tube is then rotated 90 degrees toward the bronchus that is to be intubated"—in this case the right lung—and then advanced to a depth of 27 cm (Nagelhout & Elisha, 2018, p. 633). Double-lumen tubes have a tracheal cuff and a bronchial cuff. To properly secure the DLT, the tracheal cuff requires 5-10 mL of air, and the bronchial cuff requires 1-2 mL of air.

Once placement has been established in the bronchus, "adapters are attached to the two lumens for interface with the anesthesia circuit" (Nagelhout & Elisha, 2018, p.633). "Each tube can be independently opened to the atmosphere, thereby allowing the lung on that side to collapse while ventilation to the other lung can continue" (Brodsky, n.d.). While the provider may auscultate for bilateral breath sounds, auscultation can be unreliable. Therefore, a fiberoptic scope with lubricant, which should have been prepared by the anesthesia technologist. The fiberoptic scope will be used to confirm correct placement of the DLT. A defogging solution may be used to prepare the distal tip of the scope with the camera lens if the image is foggy or unclear.

Once the airway is secured, the anesthesia provider will proceed with the placement of the arterial line. The technologist will position the arm in a dorsiflexion position, using an arm board or rolled sterile towel under the wrist. Position may be secured using tape along the fingers and thumb. The area will then be cleaned using a Chloraprep® applicator and draped using sterile towels. The anesthesia provider will don sterile gloves and begins to palpate the artery and will inserts the catheter. The anesthesia technologist will be ready for the provider to indicate when a flash is seen on the catheter and will assist in connecting the catheter to the arterial transducer extension line. Once a waveform is seen on the monitor, the technologist may secure the catheter with a bio-occlusive dressing and tape, ensuring that a waveform is ever present. Before completion of the insertion of the arterial line it is important to release the patient's arm from the dorsiflexion position and release the thumb to prevent any nerve damage.

The anesthesia provider will then continue with the next procedure, placement of the central venous line. Both the provider and technologist may use surgical scrub techniques for preparation of aseptic technique and is followed by gowning and gloving. One of the most common access sites for central venous catheters is the right internal jugular (IJ) vein, chosen for its reliable anatomy, accessibility, low complication rates, and ability to employ ultrasound guidance. "Compared to the left IJ, the right IJ forms a more direct path to the superior vena cava and right atrium. It is also wider and more superficial, making it easier to cannulate" (Kolikof et al.,2022). A subclavian approach should be avoided in this case, as the possibility for pneumothorax is higher and insertion of the catheter is on the non-operative side (Nagelhout & Elisha, 2018, p. 628). The technologist will begin by cleaning the skin with a Chloraprep® applicator along the patient's neck, extending to the ear lobe and nipple line. Once dry, sterile towels and a drape will be placed to keep the area sterile. The doctor will use the ultrasound probe to locate the IJ vein and the technologist will hand the introducer needle. A return of venous blood (dark red in color) indicates correct placement, and a guide wire will be used to guide placement of the venous access catheter. A scalpel will be used to pierce the skin along the puncture site to facilitate the insertion of the dilator and catheter over the guide wire. The dilator will be removed along with the guide wire, while the catheter remains in place. The provider will confirm placement of the catheter using the ultrasound probe and secure it using a non-absorbable suture (like silk) with a curved needle and needle driver. After suturing is done, the technologist may secure the site using a bio-occlusive dressing, and an antimicrobial patch.

The anesthesia provider will then need to treat the hypovolemic shock resulting from the left lung hemorrhage. To aid in monitoring of the patient's fluid status and fluid management the nurse will insert a foley catheter. As monitor urine output, is an analog measurement to help guide fluid replacement therapy, and an important measurement in the treatment of hypovolemia. If the body senses the loss of at least 10% of its total blood volume, the body switches into a state of anaerobic metabolism resulting in a buildup of lactic acid to maintain adequate perfusion. However, we must note that this may result in a predictable metabolic acidosis. The remaining blood is diverted to the heart and the brain, resulting in tachycardia and an initial increase in diastolic blood pressure. As more blood is lost, the tissues that are no longer receiving oxygenated blood will start to become hypoxic and die. The central venous pressure may rapidly decrease, and the patient's blood pressure will drop about 25% to 30%. Prompt and effective treatment is necessary to avoid multi-organ failure or death.

Primary therapies for hypovolemic shock involve rapidly identifying and treating the cause of the bleeding through volume replacement with fluids and blood products, along with vasopressor and inotropic support (Elisha et. al, 2012, p. 185). The CT scan in this case revealed the cause to be the left lung hematoma which will be treated with an inferior left lung lobectomy. Fluid replacement and blood product administration can be achieved through the central line. However, the anesthesia technologist will also have the Belmont Rapid InfuserÒ primed and on standby in case of increasing hemorrhage. Blood products, such as plasma, platelets, and packed RBCs are to be given at a 1:1:1 or 1:1:2 ratio which is known to provide better hemostatic outcomes compared to crystalloid-driven resuscitation (Taghavi & Askari, 2022).

Additional blood products will further help to replenish the patient's reserve post-splenectomy. The spleen is partly responsible for controlling the amount of red blood cells, white blood cells, and platelets in the body therefore the patient will be at an even larger deficit and replacement of these products is vital. The anesthesia provider will also avoid rapidly infusing isotonic crystalloids, such as 0.9% normal saline, as that can cause hyperchloremic acidosis (Eisenhut, 2006). This could further exacerbate the patient's acidotic state and could lead to a higher likelihood of tissue and organ ischemia. Instead, the anesthesia provider will administer colloid solutions, like albumin, as an alternative. In addition to blood products and fluid replacement, tranexamic acid, an antifibrinolytic, will be given to reduce blood loss from the unresolved hematoma. The anesthesia technologist ensures that vasopressors are in the room (i.e., dopamine, vasopressin, or norepinephrine) and inotropic agents. These drugs will increase the blood pressure and stabilize heart rate. Throughout the remainder of the case, the anesthesia provider should closely monitor patient pH levels, hematocrit and hemoglobin levels, blood urea nitrogen, and serum creatinine via frequent arterial blood gasses (ABG) to assess tissue perfusion, kidney function and electrolyte balance. Complete blood cell counts (CBC) and ABG values will guide the anesthesia provider to specific drug and fluid therapies to keep the patient as hemodynamically stable as possible. During this time the anesthesia technologist must remain flexible and focused as they will be very involved in supplying fluids, retrieving blood, running ABGs, or managing the BelmontÒ; whichever is needed most by the anesthesia provider.

To combat hypovolemia during the thoracotomy procedure, the anesthesia provider will utilize a permissive hypotension strategy to reduce blood loss until the lobectomy is complete. As the procedure is scheduled to last for three hours, it meets the time required to be effective and not cause damage to the patient (Ramesh et. al, 2019). Permissive hypotension is achieved by giving just enough intravenous fluids to increase systolic blood pressure but not to a normal level. In turn, this allows the vasculature to clot more quickly, further reducing bleeding. This strategy is associated with "decreased, intra-abdominal bleeding, risk of intra-abdominal hypertension, acidemia, hemodilution, thrombocytopenia, coagulopathy, apoptotic cell death, tissue injury, sepsis, volumes of crystalloid administration needed, and blood product utilization, and improved organ perfusion and survival" (Ramesh et. al, 2019).

Once the patient is intubated with the double lumen tube and all lines placed, she must be moved into a lateral decubitus position with her left side facing upward. Movement of the patient is done cautiously and with clear communication to prevent dislodging the DLT or the lines. The anesthesia technologist along with the other staff should rely on the anesthesia provider's direction throughout the movement of the patient. Once the patient is lateral, the anesthesia technologist will pass the anesthesia provider the fiberoptic scope to verify that the double lumen tube was not dislodged in any way and ventilation remains feasible. Then, the anesthesia technologist assists with securing of the patient: Sandbags are placed at the front and back of the patient; tape or a belt wrapped around the hips will secures the patient's body from sliding. The lower arm is fixed to an arm board at a right angle to the table. The upper arm is placed on an airplane board rotated forward and upward. An axillary roll placed just below the armpit will reduce the risk of brachial plexus injury. The legs must be cushioned with pillows at the knees and ankles, with the lower leg flexed and the upper leg extended straight. Upon completion of positioning, the anesthesia provider will proceed to the block.

Thoracotomies are often associated with vast amounts of pain, both visceral and somatic. A regional anesthetic will allow the patient to recover and become ambulatory much sooner postoperatively with reduced opioid assistance. Opioids cause respiratory depression and usage should be minimized as much as possible due to the patient's compromised lung. An erector spinae plane (ESP) block will be administered with the patient positioned in the right lateral decubitus position. While other blocks, such as thoracic epidural analgesia, thoracic paravertebral, or serratus anterior plane, could be used to treat thoracotomy pain, they are associated with higher rates of complications and failure due to how technically challenging they are. The ESP block, first reported in 2016, is a regional anesthetic technique that recent studies have shown to provide analgesic effects lasting more than two weeks, fewer occurrences of local anesthetic systemic toxicity (LAST), and earlier ambulatory rates (Sohby et. al, 2020). The block is performed under ultrasound guidance and involves injecting 20-30 mL of local anesthetic around the erector spinae muscle at levels ranging from T5-T12. This area allows for a greater spread of the local anesthetic and wider area of pain relief, compared to an epidural block, as it is placed in an area larger than the epidural space (Sohby et al. 2020). Additionally placing the block in myofascial tissue keeps the local anesthetic away from any major vessels, pleura, or neuraxial, attributing to fewer instances of LAST (Forero et. al, 2019).

The anesthesia technologist is responsible for gathering the supplies needed for the ESP block and assisting the anesthesia provider during block placement. The supplies needed are an ultrasound, sterile probe cover, sterile gel, sterile gloves, antiseptic skin preparation, nerve block needle, and 30 mL syringe. The technologist will sterilely prep the area while the anesthesia provider prepares 20 to 30 mL of 0.5% Ropivacaine. Once the anesthesia provider has donned their sterile gloves, the technologist will pass the ultrasound probe and look for common landmarks, such as the transverse processes and erector spinae muscle. Before the provider inserts the needle, the technologist will ensure to flush the nerve block needle of any air. Following that, once the provider is in a good position, the anesthesia technologist will aspirate by pulling back on the syringe, observing for any blood at the tip of the needle before pushing any medication. When injecting the local anesthetic, the technologist should hold the syringe with the plunger facing up so that any remaining air bubbles do not transfer into the patient. It is pivotal throughout the entire block placement for the technologist to utilize closed-loop communication with the anesthesia provider. Upon completion of the block, the surgeon will begin the surgery.

Prior to incision, suction must be discontinued from the chest tube and remain that way for the duration of the procedure. Once the lobe is exposed after the successful surgical visualization, the left lower lobectomy begins. The surgeon must first divide and dissect both the inferior pulmonary vein and interlobar pulmonary artery with a bipolar cautery device taking special caution not to nick the arterial branches of the upper lobe. Next, the left lower bronchus and lobe are divided and removed, followed by excision of the connected lymph nodes. Prior to closing, the functionality of the upper lobe must be examined either by reinflating the lung or by bronchoscopy to ensure lung compliance. Re-expansion of the lung may be achieved by reaching a peak inspiratory pressure of 30-40 cmH2O. Close observation is indicated to prevent atelectasis. In conclusion of the procedure, the surgeon will reinsert the chest tube for post-operative care.

Thoracic surgery increases airway resistance by reducing functional residual capacity (FRC). To support lung ventilation and perfusion during the maintenance period of anesthesia, medications that will least impact pulmonary function should be considered. Therefore, the anesthesia provider will discontinue the administration of propofol and will transition to a combination of ketamine, sevoflurane, and cisatracurium for the maintenance of anesthesia. The choice of a hypnotic agent will not affect pulmonary outcomes. In fact, "ketamine has direct bronchodilatory effects and antagonizes bronchoconstriction from histamine without depressing respiration". It also maintains the hypoxic pulmonary vasoconstriction (HPV) response and supports cardiovascular stability, a key factor in a hypovolemic patient (Brodsky, n.d.). Ketamine also provides "analgesic properties that can be exploited for treatment of perioperative pain", an important consideration for an open surgical approach (Nagelhout & Elisha, 2018, p.101). It is a good adjunct to the nerve block for intraoperative pain management. The sole use of intravenous agents may be considered for the maintenance of anesthesia – as a total IV anesthesia (TIVA) approach–because they do not inhibit HPV. However, volatile agents benefit thoracic surgery as they produce bronchodilatory effects and "allow the use of a high fraction of inspired oxygen to help prevent hypoxemia during one-lung ventilation" (Nagelhout & Elisha, 2018, p. 638). They also "decrease airway irritability in patients subjected to direct manipulation of lung tissue" (Nagelhout & Elisha, 2018, p. 638). Dr. Jonathan Maskin, of Huntington Health, suggests that sevoflurane be administered slowly and titrated carefully, using a low tidal volume at a higher rate, to support ventilation. For muscle relaxation, the provider may consider the use of cisatracurium because some muscle relaxants may cause histamine release. Cisatracurium is "completely devoid of any chemically mediated histamine release and can be used for patients with reactive airways" (Brodsky, n.d.).

While the left lung remains collapsed, the anesthesia provider employs one-lung ventilation (OVL). As the collapsed lung is no longer ventilating, perfusion still occurs causing a mixture of oxygenated blood from the right side and deoxygenated blood from the left. This admixture can cause arterial hypoxemia as the body begins to shunt blood from the right side to the left. Preventative measures include the administration of vasodilators, such as nitroprusside or nitroglycerin, to relax the smooth muscle and increase blood flow in the deflated lung (Brodsky, n.d.). The anesthesia provider must closely monitor EtCO2 intra-operatively as it is a value dependent on blood flow to the lung and serves as an indicator of hypoxemia.

In the event of hypoxemia, the first step is to confirm proper placement of the tube and ensure that it has not shifted. Secondly, the anesthesia provider will employ continuous positive airway pressure (CPAP) to the non-ventilated lung. It is discouraged that the provider uses the anesthesia gas machine to do this because the non-ventilated lung will have a different ventilation and perfusion mismatch ratio compared to the ventilated lung. Use of a separate device is associated with almost 100% efficacy in reversing hypoxemia (Elisha & Nagelhout, 2018, p. 640). Alternative treatment involves application of positive end-expiratory pressure (PEEP) that will recruit any collapsed alveoli, increase lung compliance, and increase functional residual capacity (Elisha & Nagelhout, 2018, p. 640). However, this is accomplished through intermittent reinflation of the operative lung. Therefore, the anesthesia provider and the surgeon must maintain effective communication during this specific treatment.

Additional ventilatory support is required for post-operative care. Therefore, the anesthesia provider will exchange the DLT for a standard ETT to ventilate both lungs. The anesthesia technologist will assist with the exchange of the tube via an airway exchange catheter. A video laryngoscope may be of assistance during this process. Once placement of the ETT has been achieved, the provider will begin the reversal of the neuromuscular blocking agent, cisatracurium, with neostigmine and glycopyrrolate. Neostigmine causes bradycardia and must be administered in combination with glycopyrrolate to increase heart rate. Complete reversal of neuromuscular blockage will be confirmed using a nerve stimulator. Since the patient will remain intubated during post-operative care, the anesthesia provider will continue sedation via a propofol drip. This will be administered once ketamine has been completely metabolized.

Post-operative ICU care is indicated for this patient, due to considerable risk of complications associated with hypovolemic shock and emergency lobectomy surgeries. To minimize barotrauma, low tidal volume ventilation and moderate levels of PEEP (less than 10 cmH2O) will be used (Yadav & Purwar, 2022). Additionally, to reduce the occurrence of air trapping when the lungs are unable to completely exhale deoxygenated air and overload the lungs, the patient must receive adequate tidal volume and expiratory pressures via controlled ventilation (Yadav & Purwar, 2022). For the management of postoperative pain, non-steroidal anti-inflammatory drugs (NSAIDs), such as Toradol, will be used. An advantage to the use of NSAIDs, in comparison to using opioids, is that they do not cause respiratory depression.

To encourage early ambulation and physical recovery, the patient should be weaned off ventilation as soon as the lungs are self-sufficient and perfusion appropriate. Ideally, the patient would be extubated after one to two days. Use of suction during extubation is critical in preventing postoperative pneumonia. A high flow nasal cannula can be employed in the occurrence of mild hypoxemia post-extubation (Yadav & Purwar, 2022). The patient will then work with a respiratory therapist to improve respiratory function. Chest tube output will be monitored multiple times daily and can be removed once fluid and air leaks achieve output less than 300 mL per day (Yadav & Purwar, 2022). Another key factor to consider, are the deficiencies post-splenectomy. The spleen contains infection-fighting white blood cells, putting the patient at elevated risk for developing infections quickly around the surgical site. Simple precautions must be taken to minimize the risk of infection. The patient will be kept hospitalized until she is cleared to be discharged by appropriate staff and criteria.

Take the QUIZ on the next page!

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Continuing Education Quiz

To test your knowledge on this issue's article, provide correct answers to the following questions on the form below. Follow the instructions carefully.

1. **What type of ventilation should be used during thoracic procedures to minimize barotrauma?**
A) High tidal volume ventilation
B) Low tidal volume ventilation
C) High-frequency oscillatory ventilation
D) Pressure-controlled ventilation

2. How is the reversal of neuromuscular blockage achieved?
A) Administering neostigmine and glycopyrrolate
B) Administering propofol
C) Administering nitrous oxide
D) Administering fentanyl

3. How can hypoxemia be reversed during one-lung ventilation?
A) Confirming proper tube placement
B) Employing continuous positive airway pressure (CPAP)
C) Using the anesthesia gas machine
D) Applying positive end-expiratory pressure (PEEP)

4. What preventative measure can be taken to avoid arterial hypoxemia during one-lung ventilation?
A) Administering vasodilators
B) Administering nitroprusside or nitroglycerin
C) Using positive end-expiratory pressure (PEEP)Administering nitroprusside or nitroglycerin
D) Monitoring EtCO2

5. Which muscle relaxant is recommended for patients with reactive airways?
A) Succinylcholine
B) Rocuronium
C) Vecuronium
D) Cisatracurium

6. Why are volatile agents beneficial for thoracic surgery?
A) They produce bronchodilatory effects They decrease airway irritability
B) They decrease blood flow to the lungs
C) They inhibit HPV
D) They decrease airway irritability

7. What size of central venous catheter is most adequate for accommodating high fluid rates?
A) 3FR
B) 5FR
C) 7 FR
D) 9 FR

8. Why is a double-lumen endotracheal tube (DLT) necessary for a thoracic lobectomy?
A) To facilitate maximal surgical exposure
B) To prevent infection
C) To administer anesthesia gases
D) To monitor the patient's oxygen saturation

9. What is a thoracic lobectomy?
A) Removal of the spleen
B) Removal of a portion of the lung
C) Removal of the gallbladder
D) Removal of the appendix

10. What does the CT scan reveal in the patient's left lung?
A) Lung contusion
B) Pulmonary embolism
C) Lung collapse
D) Lung hematoma with hemothorax

11. What does the negative pressure drain system connected to the chest tube do?
A) Allows air or fluid to drain on its own
B) Applies suction to draw air or fluid out
C) Monitors the drainage output
D) Provides oxygen to the patient

12. What is the purpose of placing a chest tube after the completion of the splenectomy?
A) To drain air and fluids from the pleural space
B) To monitor lung function
C) To administer medication directly to the lungs
D) To prevent infection

13. Why is an orogastric tube inserted following the induction of anesthesia?
A) To drain fluids from the stomach
B) To monitor gastric pH levels
C) To ensure emptying of stomach contents and deflation of distending gasses
D) To provide nutrition to the patient

14. Why was a rapid sequence induction (RSI) used for intubating the patient in the case scenario?
A) The patient had difficulty breathing
B) The patient's NPO status was unknown
C) The patient requested intubation
D) The patient had a collapsed lung

15. Which of the following procedures was ordered for the patient based on the imaging findings?
A) Emergency splenectomy
B) Appendectomy
C) Tonsillectomy
D) Hip replacement

16. Which vasodilators can be used to relax smooth muscle and increase blood flow in the deflated lung during one-lung ventilation?
A) Neostigmine and glycopyrrolate
B) Nitroprusside and nitroglycerin
C) Ketamine and sevoflurane
D) Propofol and Cisatracurium

17. What is the advantage of using non-steroidal anti-inflammatory drugs (NSAIDs) for postoperative pain management in thoracic surgery?
A) They provide sedation and analgesia
B) They do not cause respiratory depression
C) They enhance muscle relaxation
D) They increase blood flow to the lungs

Continuing Education Quiz

To test your knowledge on this issue's article, provide correct answers to the following questions on the form below. Follow the instructions carefully.

18. Which medication is commonly used for maintenance of anesthesia in intubated patients?
    A) Ketamine
    B) Sevoflurane
    C) Propofol
    D) Rocuronium

19. How is the correct placement of the double-lumen endotracheal tube (DLT) confirmed?
    A) Auscultation of breath sounds
    B) Use of a fiberoptic scope
    C) Measurement of cuff pressures
    D) Observation of bilateral chest rise

20. Why is the right internal jugular (IJ) vein commonly chosen for central venous line placement?
    A) It has a more direct path to the superior vena cava
    B) It has a lower risk of pneumothorax
    C) It is wider and more superficial
    D) It provides better ultrasound visibility

To apply for Continuing Education/ Contact Hours:

1) Provide all the information requested on this form.

2) Provide correct answers to this issue's quiz in the box to the right

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The answers to the Summer 2023 "Thoracic Lobectomy" Quiz are: (circle answers)

1. A B C D	8. A B C D	15. A B C D
2. A B C D	9. A B C D	16. A B C D
3. A B C D	10. A B C D	17. A B C D
4. A B C D	11. A B C D	18. A B C D
5. A B C D	12. A B C D	19. A B C D
6. A B C D	13. A B C D	20. A B C D
7. A B C D	14. A B C D	

Quiz 1

SUBMISSIONS FOR THIS ISSUE'S QUIZ EXPIRE **DECEMBER 31, 2024.**
ACHIEVE 80% IN THIS QUIZ TO EARN ONE (1) CONTINUING EDUCATION CREDIT.