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Complication of General anesthesia

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Introduction

Each year, increasing numbers of people are undergoing surgery. Many of these patients are older and have multiple comorbidities. General anesthesia is a reversible state of unconsciousness that allows patients to undergo surgical procedures in a safe and humane way. Although it is increasingly safe, general anesthesia is not without risks and complications. Anesthesia-related mortality is rare and has declined significantly over the past 5 decades.

Morbidity associated with general anesthesia ranges from minor complications that affect the patient's experience with no long-term consequences to complications with long-term repercussions resulting in permanent disability .

General anesthesia is a reversible state of controlled unconsciousness, produced by combination of different medicine. With general anesthesia, surgical procedures can be done to the patient, which would otherwise inflict unbearable pain. Essential to successful general anesthesia, is balanced hypnosis, analgesia and optimal muscular relaxation. It is desirable that sufficient amnesia through hypnosis is achieved .

The unconsciousness or in other words hypnosis, is accomplished by giving the patient anesthetic agents either by intravenously or as an inhalable agent. Combination of both can also be used. The effect of intravenous and inhalable hypnotic anesthetic agents is based on their effect on neurotransmitters and receptors in the central nervous system .

Being painless is a key to a successful general anesthesia and one part of the "Triangle of general anesthesia" (Figure 1). It is accomplished by giving the patient intravenous analgesics, in this case opioids. Opioids provide analgesia by binding into different types of specific opioid receptors. The binding prevents the activation of pain transmitting neurons .

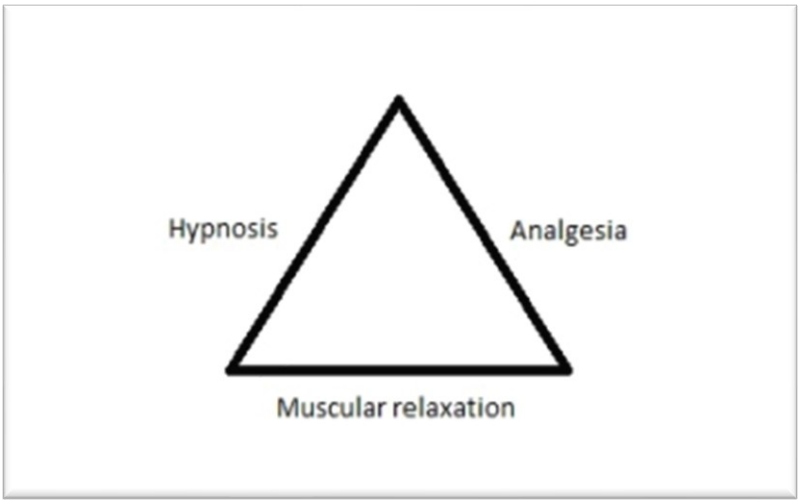

Figure 1. Triangle of anesthesia

General anesthesia

Basic of general anesthesia

The unconsciousness or we can say hypnosis, is accomplished by deliver the patient anesthetic agents either by intravenously or as an inhalable agent. Combination of both can also be used. The effect of intravenous and inhalable hypnotic anesthetic agents is depend on their effect on neurotransmitters and receptors in the central nervous system (Scheinin & Valtonen 2014, 100; Rosenberg 2014, 91). Propofol is commonly used intravenous hypnotics. Propofol was discovered as late as 1970's but it has become one of the most essential drugs used in anesthesia (Scheinin & Valtonen 2006). If inhaled anesthetics were not given, the unconsciousness can be continue with infusion of intravenous agents.

no pain is a key to a successful general anesthesia and one part of the "Triangle of general anesthesia" (see Figure 1). It is accomplished by deliver the patient intravenous analgesics, in this case opioids. Opioids gives analgesia by binding into different types of specific opioid receptors. The binding prevents the activation of pain transmitting neurons (Salomäki 2014, 116). Depending on the analgesic given, the desired effect has different on-

set time and duration. The administration is different with analgesics, from one to another. Fentanyl is deliver as repeated single doses, but for example alfentanil and remifentanil are often given as an infusion (Salomäki 2014, 121). beside to the desired analgesic effect, opioids also have some undesired effects like nausea and respiratory depression. Long-term opioid use creates a tolerance against it, which means that more doses are required for the same effect (Salomäki 2014, 119). To reach required muscular relaxation, intravenous muscle relaxants must be used. The relaxation makes the surgeon able to operate the surgical area of the patient's body. The relaxation also deactivate the function of breathing muscles, which requires the patient to be intubated and mechanically ventilated. Without muscle relaxants, intubation will be of higher risk and provide the patient extreme discomfort (Lukkari & Kinnunen 2007, 153). The influence of all muscle relaxants in clinical use is based on blocking the postsynaptic effects of neurotransmitter acetylcholine at neuromuscular junctions (Olkkola 2014, 124). Muscle relaxants are categorized in to 2 different types: depolarizing and nondepolarizing. Further categorization is divided in very short acting, short acting, intermediate acting and long acting muscle relaxants (Lukkari & Kinnunen 2007, 154). Depolarizing muscle relaxant causes cells to depolarize, with this way muscle contraction is prevented. As the alternative, non-depolarizing muscle relaxant prevents the influence of acetylcholine in the neuromuscular junction. Rocuron is one of the intermediate acting non-depolarizing muscle relaxants, which is usually used in surgical procedures. (Olkkola 2014, 125, 129.)

Different form of general anesthesia

Intravenous anesthesia is a form of general anesthesia, where the sleep is induced and kept up by deliver the patient a sufficient amount of intravenous anesthetics or a combination of intravenous anesthetics, opioids and possibly muscle relaxants (Aantaa & Scheinin 2014, 356). The goal of it is to achieve amnesia, sedation, and sleep with the dose (Kinnunen 2007, 250). This form of GA is also known as TIVA (total intravenous anesthesia), because it does not use any inhalable hypnotics (Aantaa & Scheinin 2014, 356). Inhalation anesthesia means a form of general anesthesia, which is produced by inhalable anesthetic agents alone or in combination with nitrous oxide. Some

common inhalable anesthetics deserves mentioning are sevoflurane and desflurane. Nowadays pure inhalation anesthesia is rarely used, although it's still in some operations done on children and in some less invasive operations. (Aantaa & Scheinin 2014, 351.) Combined anesthesia is the form that combines , inhalation and intravenous anesthesia togather. It is by far the most common form of general anesthesia. In the combination anesthesia the different components of anesthesia such as unconsciousness, analgesia and muscular relaxation are targeted with specific drugs. The unconsciousness is induced by giving the patient intravenous anesthetics, and then kept up with inhalable anesthetics and intravenous opioids. (Aantaa & Scheinin 2014, 350.) The order in which drugs are administered in the induction combined general anesthesia is; anticholinergics (if needed), analgesics, intravenous anesthetic and lastly the muscle relaxants (Kinnunen 2007, 254). After the intubation is done, the inhalable anesthetic is deliver to the patient through laryngeal tube or laryngeal mask.

complications of general anesthesia

Post-operative nausea and vomiting

The most common minor post-operative side effects include nausea, vomiting, sore throat or dental issues from the usage of endotracheal intubation, shivering and sleepiness. Nausea is a state of discomfort often followed by the expulsion of stomach contents, also known as vomiting. In a study done by Stadler, Bardiau, Seidel, Albert & Boogaerts (2003) it was noted that post-operative nausea and vomiting (PONV) was more frequent after operations that used general anesthesia compared to operations that used regional anesthesia. The occurrence in the recovery room ranges from an overall percentage of 20% to 30%. Postoperative nausea and vomiting is due to the effects of combined factors such as the background of the patient, surgery done, anesthesia and medication used and the environmental factors. Patient factors are female gender, previous postoperative nausea and vomiting history, tendency of motion sickness, nonsmoking status and age. Anesthesia related risk factors include the use of volatile anesthetics, extended time of surgery and anesthesia and post-operative opioid use. (Apfel, Heidrich, Jukar-

Rao, Jalota, Hornuss, Whelan, Zhang & Cakmakkaya 2012) Anesthesia risk rises through the use of volatile anesthetic agents contributing to brain stimulation leading to nausea and vomiting. usually high doses of opioids are used for pain alleviation and they are recognized to trigger nausea and vomiting. (Conway 2009.) Post-operative nausea and vomiting could be prevented and treated through a set of measures ranging from all the way from pre-admission to post-operative care. Those measures are the use of antiemetic medicine throughout the care and proper hydration through I.V. fluids. In the post-operative phase, relying on the circumstance, the patient can be kept nil per os (NPO), nothing by mouth, to forbid further nausea, although the use of ice chips will aid in the prevention. (Conway 2009.)

Pulmonary complications

Breathing is major part of a surgical procedure done in general anesthesia. The patient is dependent on the caregivers solely as his or her respiratory system is manually kept going through the use of respiratory machines. The muscle relaxants used in the induction make it so that the patients tongue blocks the airways, thus an intubation tube is inserted in order to keep the airways open. Patient Breathing should be monitored closely after the procedure as well to ensure right oxygenation levels and effortless respiration. (Niemi-Murola 2014.) The objective of the post-operative care related to respiration is to stabilize breathing of patients. Post-operative pulmonary complications, shortly referred as PPCs, are a group of complications, which are related to the respiratory system of the patients. These complications may cause in the worst-case scenario lead to further treatment after the surgery, such as intensive care unit care or further hospital stay, although through monitoring and preventive procedures the risk can be reduced. (Hadder 2013.) Risk factors for PPCs include higher American Society of Anesthesiologists classification, obesity, diabetes, smoking, advanced age, and chronic obstructive pulmonary disease (COPD) or other respiratory condition. General anesthesia is listed as one of the anesthetic causes factors, which increases the risk for said issues as it in multiple ways decreases the post-operative oxygenation levels by affecting the patient respiration and depressing pulmonary functions. Residual anesthetic drugs can also cause issues by inducing residual paralysis or residual neuromuscular blockage. (Karcz & Papadakos 2013.)

Hypoventilation

Hypoventilation, inadequate ventilation, can happen during and after the surgery and affects post-operative care. If a patient experiencing hypoventilation he can develop hypoxemia, oxygen deficiency in arterial blood, or hypoxia, impaired tissue oxygenation. Those are challenging pulmonary complications of general anesthesia. (Brander & Varpula 2014.) Hypoventilation can be caused by various reasons making it difficult to pinpoint the reason: fluid overload or pulmonary embolism, cardiac arrest, atelectasis, the complications of an underlying respiratory illness such asthma or COPD, a breathing machine error or a diffusion deficit which are all lead to a lower concentration of oxygen and higher concentration of carbon dioxide in the blood. Low oxygenation level is shown in the patient through cyanotic skin and affect the status of the patient through the higher risk of infection of wound and possible inducement of delirium. (Hadder 2013.) Inspecting the triggering agent behind the low oxygen levels starts the treatment. Patient Oxygenation is extremely important to raise the oxygenation levels to the desired range. Proper oxygenation is very important even in the transfer from the operating theater to the recovery room if the general condition of the patient indicates so [Niemi-Murola 2014].

Pulmonary atelectasis

Pulmonary atelectasis, the collapse or impaired functioning of a lung or a part of a lung, is usually common among anesthetized patients. First symptoms could be coughing, chest pain and difficulty in breathing with breathlessness. Atelectasis induce reduction of functional residual capacity, which decreases inhaled oxygen volumes. Atelectasis occurs in a complication called pneumothorax. It could be triggered by the changes in the absorption of gases and pressures occurring during general anesthesia or by a bronchial obstruction. That is results in the deflation of the alveoli, also called blebs, in the lungs. then Air is leaked into the pleural cavity from the ruptured blebs in the lung, which balances the pressure within the pleural cavity to air pressure, result in lung collapse followed by insufficient respiratory function. This occurrence adds to the risks of re-intubation and

result in post-operative hypoxemia. [Kuukasjärvi, Laurikka & Tarkka 2010; Hadder 2013.] the Mild cases of atelectasis are treated post-surgically through physiotherapy and breathing exercises, while in more major cases surgical removals of obstructions or suctioning may be necessary. This condition needs immediate medical attention; the air needs to be released from the cavity and the lung to be reflated. This could be done through insertion of a pleural drain or a chest tube. Nurse assists the doctor in the insertion of the drain through preparation of the required instruments and by assembling the draining device. [Hadder 2013.]

Pulmonary aspiration

Pulmonary aspiration of gastric contents is a serious complications, The contents of the patient's stomach flow from the esophagus and end up in the trachea as the patient is under heavy sedation and can not control swallowing and couching him or herself. [Niemi-Murola 2014.] The consequences can be acute lung damage or pneumonia that can ultimately result in death of the patient. It could happen post-operatively due to several factors. These risk factors includes emergency surgery, general anesthesia, an inexperienced anesthetist and patient dependent reasons such as lack of fasting, delayed gastric emptying or gastric hyper secretion. [Engelhardt & Webster 1999.]

Bronchospasm and laryngospasm.

Patients with an underlying respiratory condition have a higher risks of having a bronchospasm, which is a contraction of the smooth muscles in the bronchus, or a laryngospasm, the full closure of the vocal cords muscles. [Lukkarinen, Virsiheimo, Hiiva, Savo & Salomäki 2012.] These both lead to insufficient airflow and respiratory defect, then latter with a complete halt of spontaneous breathing. Spasms could develop due to a faulty state of anesthesia during the endotracheal intubation or extubation phase of the operation or because of a foreign matter or irritant [Niemi-Murola 2014]. Switching to 100% oxygen and manual ventilation starts the acute treatment of bronchospasms, If the patient is still under anesthesia, it must be deepened, as most of the volatile anesthetic agents are bronchodilators. The

Medications used in the treatment are nebulized or slow I.V. salbutamol, which is a selective beta 2-agonist, and the inhaled ipratropium bromide, which is an anticholinergic bronchodilator, Both the medications block the bronchoconstriction in the smooth muscles. In a more extreme cases adrenaline, magnesium sulphate, aminophylline and ketamine are used. (Looseley 2011.) The development of spasms can be prevented thorough cleaning of the upper airways, the avoidance of incorrect intubation and premature extubation [Koivuranta, Leutola & Ala-Kokko 2002].

Pulmonary edema

Koivuranta, Leutola and Ala-Kokko [2002] who described a patient who developed pulmonary edema as a result of a difficult laryngospasm repeated tries of inhaling with closed upper airways with a case of hypoxemia resulted in an acute pressure change in the blood circulation, creating accumulation of fluid in the lungs. Then patient was treated with oxygen and further on with CPAP to relieve the hypoxemia, pulmonary edema and the aftereffects of the laryngospasm. [Koivuranta, Leutola & Ala-Kokko 2002.] A state of the patient where there is accumulating of fluids in the lungs is called a pulmonary edema or pleural effusion. Pulmonary edema is usually a result of heart failure, as the removal of blood in the circulation of the lungs is not done adequately, Damage done to the parenchyma or vascular tissue of the lungs also results in pulmonary edema. This damage can be caused by, as previously mentioned in the patient case, repeated inhalations against the upper airway obstruction, through the aspiration of gastric fluids or through the sudden changes of pressure in the lung blood circulation. [Powell, Graham, O'Reilly & Punton 2015.] The opioids used to treat pain may also induce post-operative opioid-induced respiratory depression, where the effect of the used opioids is above the therapeutic margin, which then causes a respiratory arrest [Overdyk 2009]. This is a serious complication ultimately leading to death of the patient which could be prevented with proper recognition and monitoring. [Lee et al. 2015.] Residual neuromuscular block is also of the main causes for post-operative pulmonary complications.

Circulatory complications

General anesthesia can cause a changes in the cardiovascular function of the patient. These changes range from hypotension, hypothermia and hypovolemia to myocardial infarction, heart failure and cardiac arrest. [Harris & Chung 2013.] general anesthesia and surgery are also listed as risk factors for venous thromboembolism, which involve deep vein thrombosis and pulmonary embolism. (Desciak & Martin 2011.) Recognition of these changes and the underlying reason for them is key to start the correct treatment for the patient.

Hypotension

Post-operative hypotension can occur due to a variety of different factors, either in combination or alone. These factors either decrease the cardiac output, the systemic vascular resistance, or both of the above. These factors are vasodilation, hypovolemia ,cardiac arrhythmias or reduced myocardial contractility. (Gwinnut 2004, 75-76.)

Hypovolemia

Hypovolemia is considered the most common cause of hypotension after general anesthesia. Reason for hypovolemia most commonly is post-operative bleeding or fluid loss. Intra-operative bleeding often is more obvious and can be treated accordingly during the operation, but post-operative bleeding has a higher chance of being unnoticed. Gwinnut (2004) states that fluid loss can occur because of evaporation, which is a result of a prolonged surgery on body cavities, or as a result of tissue damage causing edema. The diagnosis of hypovolemia can be confirmed by finding tachycardia, hypotension, inadequate urine output, or reduced peripheral perfusion. To what extent these symptoms show up, it rely on the degree of hypovolemia. In the management of hypovolemia sufficient oxygenation is needed along with adequate intravenous fluids, either crystalloids or more rarely colloids. In this situation, pressure can be used to increase the speed rate of administration. In case of external hemorrhage direct pressure should be used and if any internal hemorrhage is suspected, surgical assistance should be asked. [Gwinnut 2004, 76.]

Hypertension

Post-operative hypertension is the most common amidst patients with already underlying hypertension. The existing condition can be aggravated, or entirely caused by events such as; hypoxemia, hypothermia,hypercapnia, confusion or by pain. Primary treatment for hypotension, is correcting the above-mentioned conditions – if it exists. (Gwinnut 2004, 78.) Although making unconditional recommendations about the treatment is difficult, because of the inconsistent definitions of hypertension (Haas & LeBlanc 2004, 1670). If hypertension prevails even after correcting the condition, consulting anesthesiologist and using vasodilating medicine or beta-blockers could be a help [Gwinnut 2004, 78]. Treatment of hypertension in the postoperative period is essential, because if not it can lead in grave neurological and cardiovascular complications (Haas & Leblanc 2004, 1661).

Cardiac arrhythmias

Cardiac arrhythmias can happen during or after general anesthesia. Most of the arrhythmias are benign, which is require no treatment and revert back to sinus rhythm before the patient is discharged. Preventive measures, such as monitoring, risk factor charting and choosing of the correct anesthetic agents, should be done prior the surgery. (Lorentz & Vienna 2011.) Risk factors for arrhythmias are age, ASA rating of 3 or 4, electrolyte imbalance and previous cardiovascular diseases (Harris & Chung 2013). Some anesthetic agents could cause dysrhythmias; anesthetic drugs can exacerbate the arrhythmias if the patient has a history of cardiovascular disease. The more severe arrhythmias can be corrected by the use of antidysrhytmic drugs. An early recognition of arrhythmia decrease the amount of potential harm caused by them: for example an increased beating rate of the heart, tachycardia, can result in ischemia through increased myocardial oxygen consumption (Lorentz & Vienna 2011).

Reduced myocardial contractility:

Reduced myocardial contractility can occur as a post-operative complication. Most typical cause is some sort of ischemic heart disease, which causes lack of blood supply for heart, leading to failure of the left ventricle. It is easy to mistake reduced this condition for hypovolemia, because they both share symptoms such as poor peripheral circulation or tachycardia. Even though reduced myocardial contractility has its own symptoms, an x-ray of the chest is usually often for the diagnosis. Some of those symptoms are distended neck veins or triple rhythm when auscultating the heart. The condition is managed by delivering the patient 100% oxygen, sitting him in upright position and constantly monitoring blood pressure, oxygen saturation and ECG. If the cause of reduced myocardial contractility is an acute myocardial infarction, the treatment is requires the use of vasodilators in conjunction with drugs that cause increase in the force of contractility (known as inotropes). (Gwinnut 2004, 76-77.)

Hypothermia

Post-operative hypothermia more likely appears to develop in patient that has undergone surgery with general anesthesia than with spinal anesthesia [Belayneh, Gebeyehu & Abdissa 2014]. Studies indicate that even a slight descend in core temperature of the body has great effects on some patients in certain risk groups. The effects are; two- to three times more unwanted cardiac events, doubling the amount of blood loss, and three times more likely to get infection of wound and it lengthens the time of recovery from anesthesia and the operation (Karma et al 2016, 131). During surgery, there are many factors that affect the body and core temperature of the patient. General anesthesia itself could lower the core temperature of the patient even over one Celsius. This is because general anesthesia's deactivation of the thermoregulation center of the pituitary gland, which then results in core-to-peripheral redistribution of body heat. This is the main cause of hypothermia in surgeries under general anesthesia. The usage of muscle relaxants during the operation can greatly affects the patient's muscles ability to shiver and produce heat, and that result in the temperature drop. (Sessler 2008.) If the temperature is not controlled and managed during the time of operation it can result in post-operative hypothermia. This can then

result in unwanted physiological changes in the patient after the operation. (Karma et al 2016, 131.) Because of the poor temperature distribution caused by contracted peripheral circulation, prevention of hypothermia is easier than fixing already existing one. The ways to raise temperature could be roughly divided in to two: active and passive methods. Active method stands for generating heat and passive as in preserving and isolating . (Seppänen 2013, 184-185.)

Neurologic complications

Post-operative care of the patient has to take in account the neurological issues one can have after being under general anesthesia. Post-operative cognitive dysfunction is a fairly common occurrence approximately 9.9% of patients have a cognitive level change after the surgery (Harris & Chung 2013). Inducement of emergence delirium, emotional distress and a state of psychomotor agitation with disorganized thinking after emerging from general anesthesia, causes the patient discomfort and may even be harmful to the care if their behavior turns agitated or violent. [Card, Pandharipande, Tomes, Lee, Wood, Nelson, Graves, Shintani, Ely & Hughes 2015] A study done by Card et al. (2015) they describes that 19% of the 400 enrolled patients in the study had agitated emergence and 31% had delirium signs when admitted to the post-anesthesia care unit, with a hypoactive features being the most prominent. There is No specific nursing interventions exist for treating post-operative delirium, but post-operative monitoring, early mobilization and patient guidance can help in preventing from injury or damage during hyperactive delirium (Harris & Chung 2013).

Residual neuromuscular block:

A complication called residual neuromuscular block can result in an extended recovery room period or a longer ward care. The effect of muscle relaxants that used in general anesthesia are reversed using specific antidotes, such as neostigmine or sugammadex. The reversal of muscle relaxation needs to be monitored using a train-of-four method, or by observing the patient for example lifting his or her head. If the TOF-ratio is measured to be under 0,9 after the antidote has affected, the patient may has

a residual neuromuscular block, or re-relaxation. This could be problematic to recognize and may cause increased morbidity and mortality in the post-operative care. (Yli-Olli 2013.)

Peripheral nerve damage Peripheral nerve damage, which is caused during the perioperative phase, may result in severe complications after the operation. In the case of general anesthesia the patients is rendered immobile, which makes the patients greatly relying on the caretakers in regards of changing his or her position during the operation. If a nerve is stretched, compressed or kept in an extreme position for a longer duration of time, it could lead to aforementioned nerve damage. The most common nerves to be injured are the ulnar nerve and the common peroneal nerve. (Tighe 2009.) The operational staff has multiple different protection methods to prevent such injuries from happening. Most are based on the usage of soft materials and the change of center of gravity on a specific body part. (Tunturi 2013.) A common fear among patients whose going to surgery is awareness during general anesthesia. If a patient is aware due to an inadequate depth of anesthesia during surgery, it can lead to post-operative anxiety, depression and even post-traumatic stress disorder. This is fortunately extremely rare (0.03%) and is prevented by the use of thorough monitoring and anesthetic use. [Harris & Chung 2013.]

Renal complications

Initial reports described the effects of ether anaesthesia where, following induction, a marked increase in both urine output and non-protein nitrogen excretion was noted. However, after 90 min of anaesthesia, both parameters had decreased to just 3.6% and 2.2% of baseline, respectively. At 24 h postoperatively, recovery to 43% and 84% of baseline was observed, with earlier recovery of secretory rather than nitrogenous excretory function.Acute kidney injury may complicate up to 20% of all hospital admissions and is recognised as a major complication of surgery, with approximately 30–40% of cases of hospital-acquired AKI occurring in the perioperative setting. Moreover, the development of AKI in the peri-operative period is associated with increased risks of sepsis, coagulopathy and prolonged mechanical ventilation.

Hepatic complications

Clinically significant derangements of the liver enzymes alanine aminotransferase (ALT) and aspartate aminotransferase (AST) are uncommon after anaesthesia in healthy individuals. Elevations in serum bilirubin are more common, multifactorial in nature, and usually clinically insignificant. De novo acute liver dysfunction as a complication of anaesthesia occurs rarely. However, anaesthesia-induced hepatitis (AIH) is associated with significant mortality. Severe liver dysfunction as a consequence of anaesthesia is not uncommon in patients with pre-existing liver disease. It is important that this high-risk patient group is recognized pre-operatively Anaesthesia-induced hepatitis (AIH) has been associated most commonly with halothane.

Awareness

Awareness under anaesthesia is the ability to recall events occurring during general anaesthesia. Hearing is the last sense to disappear under anaesthesia. Anaesthetists rely on clinical observation of motor movement and sympathetic nervous system stimulation (hypertension, tachycardia, sweating or lacrimation) to assess the depth of anaesthesia. Motor movement will be masked by muscle relaxants and sympathetic signs modified by β-blockers and opiates. Objective methods to measure awareness using processed electro-encephalogram (EEG) data have been developed, but are not always available.

Examples of this are the Bispectral Index (BIS® - Aspect) and Entropy (Datex-Ohmeda). Causes of awareness include faulty equipment and light anaesthesia. Awareness due to inadequate volatile agent is reduced by the use of an anaesthetic agent analyser to measure the concentration of the anaesthetic agent in the breathing circuit. Benzodiazepines are also extremely useful due to their ability to cause anterograde amnesia. Awareness is an extremely uncommon event and the incidence ranges from 1 in 10 000 for conscious awareness with pain; to 1 in 1 000 people being able to report some awareness in the postoperative interview, although not in any way distressing. The first type where the patient is fully aware while being paralysed and feels pain is the worst scenario and can lead to the patient developing post-traumatic stress disorder. These patients should be followed up regularly, and referred for psychiatric help if necessary.

Difficult recovery

The recovery period for some patients can be challenging and unpleasant. It is during the recovery period where most deaths occur. Patients in the recovery period should have supervision for at least the first few hours post-extubation. Two common recovery complications are: delayed recovery (>30 mins since termination of anesthesia) and rapid recovery with or without pain.Delayed recovery may be an indication excessive depth or slow elimination (hepatic, renal disease, poor perfusion, etc.)) of anesthetic agents. Hypothermia can also cause a delayed recovery.A prolonged recovery may be an indication of a serious condition that may eventually result in death of the patient.

A slow recovery causes depressed ventilation and slow elimination of inhalant anesthetics; this will further exacerbate hypothermia and slow metabolism (of injectable anesthetics) resulting a slower return to consciousness. If a slow recovery is a result of hypothermia appropriate warming therapy (warm environment, warm IV fluids, warm water or warm air circulating blankets, and warm laundry) should begin immediately. Pre-warming and minimizing anesthesia time can help prevent this from happening.

If reversible anesthetic agents were used (opioids, alpha-2 agonists, benzodiazipines) reversal agents (antisedan, flumazenil) should definitely be considered to expedite the recovery process (keeping in mind patient comfort).On the other hand, a rapid recovery is also not desirable. Patients waking up too quickly can be very distressing to all involved. These patients are in danger of injuring themselves (and others).

Ideally, all patients should be placed in a warm, quiet environment prior to extubation to minimize as much post-anesthetic excitement as possible.

During a “stormy”, rapid recovery it will be important to determine what may have caused this inappropriate “wake-up”. Is it a result of pain or dysphoria, anxiety/agitation for anesthetic agents? This can be a very challenging time not only for the patient but also for the anesthetist/recovery nurse. It may require a multi-step process to get these patients “settled”. Various anesthetics (dissociatives, tranquilizers, opioids) can cause unwanted behavior changes. If dysphoria is suspected as a result of opioid use, a partial reversal may be required. Butorphanol 0.05mg/kg IV can be administered to take away some of the unwanted behavior.

A low tranquilizer may be beneficial for mild sedation and calming. Acepromazine 0.01mg/kg IV or dexmedetomidine 0.002 mg/kg IV can be used.If pain is the cause of a rough recovery, additional analgesia should be administered.

Equipment failure

The anaesthetic machine, ventilator, tubing, vaporisers, intubation equipment, cabling and monitors can all malfunction. Faulty equipment or lack of essential equipment can lead to disastrous outcomes such as failure to ventilate, hypoxia, awareness, electrical shock and burns. All equipment must be checked prior to an anaesthetic. Warning alarms should be in place such as an oxygen failure alarm and oxygen analyser. Monitoring alarms should be set to detect any adverse clinical parameters and abnormal ventilatory pressures. A self-inflating emergency resuscitator, e.g. Ambu® bag, and an oxygen cylinder should be available in case of ventilator failure. Equipment must be serviced and calibrated at appropriate intervals.

Conclusion

There are many risk and complications of general anesthesia that need to be researched vigoursly and prevented immediately because of their potential morbidity and mortality. More anesthetic research should be performed to identify the susceptibility of the patients and possible risk factors for general anesthesia.

References

1.Bainbridge D, Martin J, Arango M, Cheng D, Evidence-based Peri-operative Clinical Outcomes Research (EPiCOR) Group. Perioperative and anaesthetic-related mortality in developed and developing countries: a systematic review and meta-analysis. The Lancet. 2012 Sep 22;380(9847):1075-81.

2.Niemi-Murola L. Yleisanestesian perusteet. Teoksessa Jalonen, J., Junttila, E., Metsävainio, K., Niemi-Murola, L., Pöyhiä, R., Saari, T. ym. Anestesiologian ja tehohoidon perusteet. 2016.

3.Paavolainen L, Wallstedt J. Post-operative complications of general anesthesia: a recorded video presentation.2014.

4.Olkkola K, Takkunen O. Anestesiologia ja tehohoito. Helsinki: Duodecim. 2014:14-5.

5.Aantaa, R. & Scheinin, H. 2014. Anestesiologia ja Tehohoito 3 edition. Inhalaatioanestesia ja laskimoanestesia. 351, 356. Helsinki: Duodecim.

6.Apfel, C., Heidrich, F., Jukar-Rao, S., Jalota, L., Hornuss, C., Whelan, R., Zhang, K. & Cakmakkaya, O. 2012. Evidence-based analysis of risk factors for postoperative nausea and vomiting. Accessed on 20 October 2016. Retrieved from: http://bja.oxfordjournals.org/content/109/5/742.full.pdf+html

7.Belayneh, T., Gebeyehu, A. & Abdissa, Z. 2014. Post-operative Hypothermia in Surgical Patients at University of Gondar Hospital, Ethiopia. Accessed on 1 February 2016. Retrieved from: http://www.omicsonline.org/open-access/postoperativehypothermia-in-surgical-patients-at-university-of-gondar-hospital-ethiopia-2155-6148.1000461.pdf

8.Brander, P. & Varpula, T. 2014. Keuhkosairaudet. Hengitysvajaus. Kaasujenvaihtohäiriö. Helsinki: Kustannus Oy Duodecim. Accessed on 1 October 2016. Retrieved from http://www.oppiportti.fi.ezproxy.jamk.fi:2048/op/kes00225/do

9.Card, E., Pandharipande, P., Tomes, C., Lee, C., Wood, J., Nelson, D., Graves, A.,

10.Shintani, A., Ely, E. & Hughes, C. 2015. Emergence from general anaesthesia and evolution of delirium signs in the post-anaesthesia care unit. Accessed on 22 October 2016. Retrieved from: https://www.ncbi.nlm.nih.gov/pubmed/25540068

11.Conway, B. 2009. Prevention and Management of Postoperative Nausea and Vomiting

in Adults. Accessed on 13 September 2016. Retrieved from Cinahl:

http://search.ebscohost.com.ezproxy.jamk.fi:2048/login.aspx?direct=true&db=c8h

&AN=105428984&site=ehost-live

12. Cronin, P., Ryan, F. & Coughlan, M. 2008. Undertaking a literature review: a step-bystep approach. Accessed on 4 March 2016. Retrieved from:

http://www.cin.ufpe.br/~in1002/leituras/2008-undertaking-a-literature-review-astep-by-step-approach.pdf

13.Desciak, M. & Martin, D. 2011. Perioperative pulmonary embolism: diagnosis and

anesthetic management. Accessed on 12 October 2016. Retrieved from:

http://www.cinj.org/sites/cinj/files/documents/PerioperativePulmonaryEmbolism

.pdf

14.Engelhardt, T. & Webster, N. R. 1999. Pulmonary aspiration of gastric contents in

anaesthesia. Accessed on 3 February 2016. Retrieved from:

http://bja.oxfordjournals.org/content/83/3/453.full.pdf

15.Gwinnut, C. 2004. Clinical anesthesia 2nd edition. Postanesthesia care. 75-76. Blackwell

Publishing ltd.

16.Haas, C. & LeBlanc, J. 2004. Acute postoperative hypertension: A review of therapeutic

options. American Journal of Health-System Pharmacy Vol 61. 1661, 1670.

Accessed on 27 October 2016. Retrieved from http://tinyurl.com/hpjxox6

17.Hadder, B. 2013. Pulmonary Complications after General Anesthesia. Accessed on 17

July 2016. Retrieved from:

http://www.anesth.uiowa.edu/Portals/0/Lectures/Cabo%20Lectures/2013%20Lect

ures/4.%20Pulmonary%20Complications%20after%20General%20Anesthesia%20

-%20Hadder.pdf

18.Harjola, V. & Mustonen, P. 2016. Kardiologia. Keuhkoembolia ja pulmonaarihypertensio. Helsinki: Kustannus Oy Duodecim. Accessed on 1 October 2016. Retrieved from http://www.oppiportti.fi.ezproxy.jamk.fi:2048/op/kar01375/do

19.Harris, M. & Chung, F. 2013. Complications of General Anesthesia. Accessed on 13 October 2016. Retrieved from http://tinyurl.com/j48qmvd

20.Hoikka, A. 2013. Anestesiahoitotyön käsikirja. Happeutuminen ja ventilaatio. 26. Helsinki: Duodecim

21.Hoikka, A. 2013. Anestesiahoitotyön käsikirja. Sydämen toiminta ja verenkierto. 40. Helsinki: Duodecim

22.Jyväskylän Ammattikorkeakoulu 2013. Jyväskylän ammattikorkeakoulun eettiset periaatteet. Accessed on 30 October 2016. Retrieved from:

23. Aveyard, H. 2010. Doing a Literature Review in Health and Social Care. A Practical Guide. 2nd Edition. Open University Press. England. McGraw-Hill Companies