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Post-operative complications of general anesthesia

A recorded video presentation

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Abstract

The use of general anesthesia is considered safe, but it comes with certain risks. General anesthesia has countless minor and major complications. The recognition and treatment of the complications is important when providing good-quality care. Nurses working in the perioperative field carry a major responsibility of recognizing and acting upon various complications, which, if untreated, may lead to slow recovery, permanent damage or even death.

The aim was to study the post-operative complications of general anesthesia. The purpose of this study was to use the retrieved information to provide a compact, informative and easy-to-use learning material in the format of a video presentation for nursing students undertaking their perioperative studies.

The study was carried out using methodologies based on evidence-based development. A database literature search for current, evidence-based medical and nursing literature was performed in order to achieve a reliable and professional end result. The presentation was made using pedagogical principles, and it utilizes video and sound so as to make it an attractive learning tool.

Keywords (subjects)

Perioperative, post-operative, general anesthesia, nursing, complication, video, presentation

Miscellanous

The video presentation in JAMK moniviestin: http://moniviestin.jamk.fi/ohjelmat/luennot/post-operative-complications-of-general-anesthesia/a-video-presentation

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1 Introduction

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. (Niemi-Murola 2014.)

The use of general anesthesia is increasingly safe, but it may come with certain risks and complications. These complications range from an instant perioperative issues such as an anesthetic anaphylaxis to minor and major post-operative complications. The minor post-operative complications are common and include throat soreness, post-operative nausea and vomiting and dental damage. The major complications consist of pulmonary, circulatory and neurologic complications. The range of different medication and techniques used during general anesthesia and the patient's own general condition can induce an array of these issues. It is important for nurses to know how to react and observe changes in order to prevent such complications from causing major damage, further complications and hospital care, or even possible death. (Harris & Chung 2013.)

The research topic of this thesis is to study the post-operative complications of general anesthesia and use that information to create a recorded video presentation with to provide material for nursing students of JAMK undergoing their perioperative studies. The approach taken to this subject is literature search along with the recorded presentation.

2 General anesthesia

2.1 Foundations of general anesthesia

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 (Scheinin & Valtonen 2014, 100; Rosenberg 2014, 91). Propofol is one of the most 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 are not given, the unconsciousness can be kept up with infusion of intravenous agents.

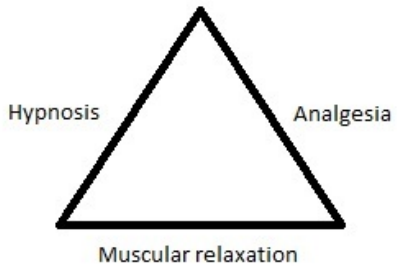

Figure 1. The triangle of general anesthesia

Being painless is a key to a successful general anesthesia and one part of the "Triangle of general anesthesia" (see 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 (Salomäki 2014, 116). Depending on the analgesic given, the desired effect has different on-set time and duration. The administration is also different with analgesics, from one to another. Fentanyl is given as repeated single doses, but for example alfentanil and remifentanil are usually given as an infusion (Salomäki 2014, 121). In addition to the desired analgesic effect, opioids also have some undesired effects such as nausea and respiratory depression. Long-term opioid use creates tolerance against it, which means that greater doses are required for the same effect (Salomäki 2014, 119).

To achieve required muscular relaxation, intravenous muscle relaxants must be used. The relaxation makes it possible for the surgeon to operate the surgical area of the patient's body. The relaxation also disables the function of breathing muscles, which requires the patient to be intubated and mechanically ventilated. Without muscle relaxants, intubation would be of higher risk and provide the patient extreme discomfort (Lukkari & Kinnunen 2007, 153). The effect of all muscle relaxants in clinical use is based on preventing the postsynaptic effects of neurotransmitter acetylcholine at neuromuscular junctions (Olkkola 2014, 124). Muscle relaxants are categorized in to two different types: depolarizing and non-depolarizing. 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, and this way muscle contraction is prevented. As the alternative, non-depolarizing muscle relaxant prevents the effect of acetylcholine in the neuromuscular junction.

Rocuron is one of the intermediate acting non-depolarizing muscle relaxants, which is commonly used in surgical procedures. (Olkkola 2014, 125, 129.)

2.2 Different forms of general anesthesia

Intravenous anesthesia is a form of general anesthesia, where the sleep is induced and kept up by giving 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 is to achieve amnesia, sedation and sleep with the dose (Kinnunen 2007, 250). This form of anesthesia 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 worth mentioning are sevoflurane and desflurane. Nowadays pure inhalation anesthesia is rarely used, although still in some operations done on children and in some less invasive operations. (Aantaa & Scheinin 2014, 351.)

Combined anesthesia is the form that combines both, inhalation and intravenous anesthesia. It is by far the most common form of general anesthesia. In 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 the drugs are administered in the induction combined general anesthesia is; anticholinergics (if needed), analgesics, intravenous anesthetic and last the muscle relaxants (Kinnunen 2007, 254). After the intubation is done, the inhalable anesthetic is given to the patient through laryngeal tube or laryngeal mask.

2.3 Observing and monitoring during general anesthesia

Surgery and anesthesia cause the patients vital signs to change. The effect of the change depends on the patient's health and how complex the surgery and anesthesia is. In cases of large operations or non-healthy patients, even the anesthesia itself presents a risk for unstable vitals. Observation is done by seeing, hearing, perceiving, asking, feeling and by recording and analyzing information. All of these make up one big picture, where the nurse anesthetist is using his or her senses and critical thinking, to analyze the information subjectively. To ensure patient safety, different forms of monitoring are used in general anesthesia. Monitoring leads to prevention, early recognition and treatment of possible complications. Different equipment is used in monitoring of the patient; Figure 2 shows an Infinity Delta monitor with monitored values depicted as graphs and numerical values. (Lukkari et al 2013, 305.)

Figure 2. Infinity Delta monitor

Breathing is closely monitored and observed, because in every general anesthesia the risk of respiratory depression is always present (Salmenperä & Yli-Hankala 2014, 307). The goal of monitoring breathing is to identify sudden or developing breathing deficiency. During the operation, breathing is monitored with the pulse oximeter and by observing the breathing frequency, pressure, breathing movements and sounds, oxygenation and gas exchange (Hoikka 2013, 26). The monitor provides a capnogram, which is a graphical representation of the amount of carbon dioxide entering and leaving the lungs. The measurement provides information whether the ventilation is sufficient enough or not. During combination and inhalation anesthesia, various settings of the ventilator are also observed, such as minute volume, single volume, airway pressure and oxygen flow. (Karma et al 2016, 120-121.)

Circulation is monitored to ensure sufficient oxygenation for tissues and to

prevent hypoxia (Salmenperä & Yli-Hankala 2014, 311). During general anesthesia patient's circulation is monitored by measuring blood pressure, pulse, temperature, blood volume and diuresis (Hoikka 2013, 40). Blood pressure can be monitored either by non-invasive or invasive method, where the invasive method requires an arterial cannula. The invasive blood pressure monitoring provides a continuous stream of data, whereas the non-invasive method measures the blood pressure usually once every five minutes. (Salmenperä & Yli-Hankala 2014, 314-315.) Patient is also connected to the electrocardiogram (EKG or ECG) to provide data on the electrical activity of the heart. By observing the ECG, information is gained about the changes in the pulse, myocardial ischemia, arrhythmias, electrolyte imbalances and various myocardial diseases (Liukas, Niiranen & Räisänen 2013, 44). In more complex operations, central venous pressure (CVP) might also be needed to monitor the blood volume and pressure (Salmenperä & Yli-Hankala 2014, 317).

Temperature should be actively monitored and losses of temperature treated accordingly. Surgery typically exposes the patient for loss of temperature, such as; cool environment of the operating room, administration of unwarmed intravenous fluids, evaporation from within surgical incisions, vasodilation caused by anesthesia and exposure of skin to make needed preparations (Karma et al 2016, 132). Temperature can be monitored by measuring the peripheral temperature, or by measuring core temperature of the body. When measuring core temperature only, one must keep in mind that body reacts to the loss of temperature first by trying to preserve the core temperature around vital organs, on the expense of peripheral temperature. For that reason, core temperature might be inaccurate to show the real loss of temperature in acute situations. (Salmenperä & Yli-Hankala 2014, 329.) Most accurate and ideal locations for

monitoring core temperature are the pulmonary artery, nasopharynx and distal esophagus. These locations might not always be available, or require invasive monitoring, like in the case measuring temperature from the pulmonary artery. Locations like bladder, mouth and rectum are slow in terms of monitoring, but usually more easily available. These have some limitations, but can be used clinically in appropriate circumstances. (Sessler 2008.) Observing the color, moisture and temperature of skin should not be forgotten even with other monitoring attached to the patient (Karma et al 2016, 133).

Fluid balance and blood volume are observed throughout the operation. General fluid therapy principles are followed; basic need for fluids is taken care of and additional fluid losses, such as blood loss or evaporation are also treated accordingly. The goal for intra-operative fluid therapy is to maintain the body's own fluid and electrolyte balance, so that the metabolism would function as normal as possible through the whole operation and during recovery. With fluid therapy, normal function of kidneys and natural blood flow are ensured. Fluid balance is monitored during general anesthesia by observing the relation of ingoing and outgoing fluid amount. Functioning of cannulas and tools used with fluid infusions, such as perfusors, is also essential to provide the patient with good quality fluid therapy. Blood volume is monitored by observing skin color, temperature, pulse, blood pressure, blood loss, breathing frequency and diuresis. (Karma et al. 2016, 125-126.) When measuring the amount of blood loss, different factors should be added up together. These factors are; assessing the amount of blood suctioned, by weighing surgical swabs to estimate the amount of blood absorbed in them and all else that can be seen with bare eyes (e.g. blood on the floor and blood absorbed into surgical dressings) (Tunturi 2013, 153.)

Diuresis is observed to assess the functioning of kidneys, to note sufficient diuresis of about 1ml/kg/hour and to assess the fluid balance and circulation of the patient (Lukkari et al 2007, 326). To monitor the amount of diuresis, a urine catheter is used. Although not all patients who go under general anesthesia, are catheterized. Some motives for catheterization are; heart failure, acute kidney failure, prolonged hypotension, hypovolemia or in case an operation is suspected to last more than five hours. Certain types of operations also require it, such as; urological, neurosurgical or cardiac operations, along with any other major ones. In the end, it comes down to the operating surgeon or the anesthesiologist to decide if catheterization is needed or not. (Karma et al 2016, 133.) Urine output is monitored cumulatively, which means that hourly diuresis and total diuresis are monitored separately (Lukkari et al 2007, 326).

Muscle relaxation observation is needed during the induction, reversing and in the upkeep of hypnosis. Before intubation or extubation is done, proper relaxation is essential to ensure safety of the procedure. During the upkeep phase of hypnosis, the need of muscle relaxant is based on the need of surgical procedure being done. (Lukkari et al 2007, 318.) Relaxation is monitored by peripheral nerve stimulation. Most often two electrodes are attached on top of the ulnar nerve on the volar side of wrist. The stimulator is placed on the thumb of the patient, from where it sends the electrical stimulation towards the electrodes. Most commonly used measurement is called TOF (train-of-four), where the stimulator sends four of those electrical stimulation signals and then the amount and strength of signals reaching the electrodes is measured. TOF measurement should only be started after the patient is already sleeping. (Karma et al 2016, 127-128.)

Pain and sleep are observed to ensure optimal hypnosis and analgesia, so the operation can be done without unpleasant experiences for the patient. Observing pain and hypnosis is also important, so that right balance of medicine can be given. Too much of hypnotics or analgesics, could have malevolent side-effects and a prolonged recovery phase. In observing pain and sleep, you have to pay attention to many different details. It is important to know, how the patient's vitals are and how the patient looks and feels, when everything is just right. Only then you can make the comparison, if the patient is feeling pain or lingering in too shallow hypnosis. (Karma et al 2016, 129.) When measuring the depth of the hypnosis multiple parameters should always be followed (Liukas et al 2013, 175). Some common signs in vitals for the feeling of pain, are elevated heartrate and blood pressure. (Karma et al 2016, 129.) For hypnosis in inhalation or combined anesthesia, the amount of anesthetics going in and out, must be monitored closely. BIS (bispectral index scale) monitoring can be used in measuring hypnosis. BIS is based on electroencephalography monitoring, which records the electrical activity of the brain (Lukkari et al 2007, 322).

2.4 Roles of staff during general anesthesia

During the procedure, the anesthesiologist and the nurse anesthetist work as team. Anesthesiologist is responsible for the medical care and treatment of the patient. Nurse anesthetist is responsible for observing and treating the patient during anesthesia. Actions of the nurse anesthetist are based on the plan made by the anesthesiologist. These actions also include execution of given orders and as Pöyhiä & Pöyhiä state in their article (2011); nurse anesthetist needs to know,

when an anesthesiologist should be called to the operation. Good professional anesthesia team is considered as the most important safety factor in perioperative care. (Lukkari et al 2013, 305.)

2.5 ASA physical status classification system

ASA (American Society of Anesthesiologists) classification is a simple way to describe the fitness of patient undergoing surgery and anesthesia. The risk for intra and post-operative complications is assessed on a scale from one to five. The classification is not based on any mathematical model or patient data and it is originally developed for collection and tabulation of statistical data. It is relatively easy to determine the ASA class, but there is still dispersion among anesthesiologists. The system has been criticized, that it does not systematically involve all risk factors for anesthesia. In cases like pre-existing condition of difficult intubation, anesthesiologists usually just raise the ASA class, even though it does fully fit in the description of that class. In case of an emergency operation, the elevated risk of complication is noted with marking “E”, instead of raising the ASA class. (Kontinen & Hynynen 2003, 340-341.) In Finland, five different ASA classes are used (see Table 1).

Table 1. ASA classification in Finland

1	Healthy under 65 of age
2	Healthy over 65 of age, or person with mild systemic disease
3	Person with severe, non-life-threatening systemic disease
4	Person with severe systemic disease, that constantly threatens life
5	Moribund patient, who is not expected live more than 24 hours without an operation

3 Post-operative complications involving general anesthesia

3.1 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%. Post-operative 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 post-operative 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 rises as a risk through the use of volatile anesthetic agents contributing to brain stimulation leading to nausea and vomiting. Often 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 can be prevented and treated through a set of measures ranging from all the way from pre-admission to post-operative care. These measures are the use of antiemetic medicine throughout the care and proper hydration through I.V. fluids. In the post-operative phase, depending on the circumstance, the patient can be kept nil per os (NPO), nothing by mouth, to prevent further nausea, although the use of ice chips will aid in the prevention. (Conway 2009.)

3.2 Pulmonary complications

Breathing is a major part of a surgical procedure done in general anesthesia. The patient is solely dependent on the caregivers 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. Breathing of the patient 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 the patients breathing.

Post-operative pulmonary complications, shortly referred as PPCs, are a group of complications, which are related to the patient's respiratory system. These complications may in the worst-case scenario lead to further treatment after the surgery, such as intensive care unit care or further hospital stay, though through monitoring and preventive procedures the risk can be reduced. (Hadder 2013.) Risk factors for PPCs include higher American Society of Anesthesiologists classification, diabetes, obesity, advanced age, smoking and chronic obstructive pulmonary disease (COPD) or other respiratory condition. General anesthesia is listed as one of the anesthetic causes, which increases the risk for said issues as it in multiple ways decreases the post-operative oxygenation levels by affecting the respiration of the patient and depressing pulmonary functions. Residual anesthetic drugs also cause issues by inducing residual paralysis or residual neuromuscular blockage. (Karcz & Papadakos 2013.)

Hypoventilation

Hypoventilation, inadequate ventilation, can occur during and after the surgery and affects post-operative care. A patient experiencing hypoventilation can develop hypoxemia, oxygen deficiency in arterial blood, or hypoxia, impaired tissue oxygenation. These 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 as asthma or COPD, a breathing machine error or a diffusion deficit which all lead to a lower concentration of oxygen and higher concentration of carbon dioxide in the blood. Low oxygenation levels are shown in the patient through cyanotic skin and affect the status of the patient through the higher risk of wound infection and possible inducement of delirium. (Hadder 2013.) Inspecting the triggering factor behind the low oxygen levels starts the treatment. Oxygenation of the patient is extremely important to raise the oxygenation levels to the desired range. Proper oxygenation is 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 very common among anesthetized patients. First symptoms can be coughing, chest pain and difficulty in breathing with breathlessness. Atelectasis results in the reduction of functional residual capacity, which decreases inhaled oxygen volumes. Atelectasis occurs in a complication called pneumothorax. It can be triggered by the changes in the absorption of gases and pressures occurring during general anesthesia or by a bronchial obstruction. This results in the deflation of the alveoli, also called blebs, in the lungs. Air is then leaked into the pleural cavity from the ruptured blebs in the lung, which balances the pressure within the pleural cavity to air pressure, leading to lung collapse followed by insufficient respiratory function. This occurrence adds to the risk of re-intubation and inducing post-operative hypoxemia. (Kuukasjärvi, Laurikka & Tarkka 2010; Hadder 2013.) 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 reflated. This can be done through insertion of a pleural drain or a chest tube. Nurse assists a 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 complication. The contents of the patient's stomach rise up from the esophagus and end up in the trachea as the patient is under heavy sedation and cannot control swallowing and couching him or herself. (Niemi-Murola 2014.) The consequences can be acute lung damage or pneumonia that can ultimately lead to death of the patient. It can happen post-operatively due to several factors. These risk factors include 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 risk of having a bronchospasm, which is a contraction of 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, the latter with a complete halt of spontaneous breathing. Spasms can develop due to a faulty state of anesthesia during the endotracheal intubation or extubation phase of the operation or due to 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. Medications used in the treatment are nebulized or slow I.V. salbutamol, which is a selective beta 2-agonist, and inhaled ipratropium bromide, which is an anticholinergic bronchodilator. Both medications block the bronchoconstriction in the smooth muscles. In more extreme cases adrenaline, magnesium sulphate, aminophylline and ketamine are used. (Looseley 2011.) The development of spasms can be prevented with thorough cleaning of the upper airways, the avoidance of incorrect intubation and pre-mature extubation (Koivuranta, Leutola & Ala-Kokko 2002).

Pulmonary edema

Koivuranta, Leutola and Ala-Kokko (2002) described a patient who developed pulmonary edema as a result of a very 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 fluid accumulation in the lungs. The patient was then 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 fluids are accumulating in the lungs is called a pulmonary edema or pleural effusion. Pulmonary edema is often 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 an upper airway obstruction, through the aspiration of gastric fluids or by 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 a main cause for post-operative pulmonary complications. It is explained in detail in chapter 3.4.

3.3 Circulatory complications

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

Hypotension

Post-operative hypotension can happen due to a variety of different factors, either in combination or alone. These factors either reduce the cardiac output, the systemic vascular resistance, or both of the above. These factors are; hypovolemia, vasodilation, 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 often is post-operative bleeding or fluid loss. Intra-operative bleeding usually 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 happen because of evaporation, which is a result of a prolonged surgery on body cavities, or as a result of tissue damage leading to edema. The diagnosis of hypovolemia can be confirmed by finding tachycardia, inadequate urine output, hypotension or reduced peripheral perfusion. To what extent these symptoms show up, depends on the degree of hypovolemia. In 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 speed up the rate of administration. In the 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 most common amidst patients with already underlying hypertension. The existing condition can be aggravated, or entirely caused by events such as; hypothermia, hypoxemia, hypercapnia, confusion or by pain. Primary treatment for hypotension, is correcting the above-mentioned conditions – if one exists. (Gwinnut 2004, 78.) Although making unconditional recommendations about the treatment is hard, 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 of help (Gwinnut 2004, 78).

Treatment of hypertension in the postoperative period is essential, because untreated it can result in grave neurological and cardiovascular complications (Haas & Leblanc 2004, 1661).

Cardiac arrhythmias

Cardiac arrhythmias can occur during or after general anesthesia. Most of the arrhythmias are benign, which 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 correct anesthetic agents, should be done prior the surgery. (Lorentz & Vienna 2011.) Risk factors for arrhythmias are age, ASA rating of 3 or 4, previous cardiovascular diseases and electrolyte imbalance (Harris & Chung 2013). Some anesthetic agents can cause dysrhythmias; anesthetic drugs can exacerbate the arrhythmias if the patient has a history of cardiovascular disease. The more severe arrhythmias can be corrected through the use of antidysrhytmic drugs. An early recognition of arrhythmia reduces the amount of potential harm caused by them: for example an increased beating rate of the heart, tachycardia, can lead to ischemia through increased myocardial oxygen consumption (Lorentz & Vienna 2011).

Reduced myocardial contractility

Reduced myocardial contractility can happen as a post-operative complication. Most typical cause is some sort of ischemic heart disease, which causes lack of blood supply for heart, resulting in failure of the left ventricle. It is easy to mistake reduced this condition for hypovolemia, because they both share symptoms such as tachycardia or poor peripheral circulation. Even though reduced myocardial contractility has its own symptoms, an x-ray of the chest is usually needed for the diagnosis. Some of these symptoms are distended neck

veins or triple rhythm when auscultating the heart. The condition is managed by giving 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 requires the use of vasodilators in conjunction with drugs that increase the force of contractility (known as inotropes). (Gwinnut 2004, 76-77.)

Hypothermia

Post-operative hypothermia appears to develop more likely in patients that have 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 of certain risk groups. The effects are; two- to three times more unwanted cardiac events, doubling the amount of blood loss, three times more likely to get a wound infection and it lengthens the time of recovery from anesthesia and the operation (Karma et al 2016, 131). During surgery, there are multiple factors that affect the body and core temperature of the patient. General anesthesia itself can lower the core temperature of the patient even over one Celsius. This is due to 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 reason of hypothermia in surgeries under general anesthesia. The usage of muscle relaxants during the operation greatly affects the patient's muscles ability to shiver and produce heat, thus resulting in the temperature drop. (Sessler 2008.) If the temperature is not controlled and managed during the operation it can result in post-operative hypothermia. This can then lead to 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 can be roughly divided in to two: active and passive methods. Active method stands for generating heat and passive as in preserving and isolating (see Table 2). (Seppänen 2013, 184-185.)

Table 2. Active and passive methods of warming

Active methods	Air warming machines and blankets
	Warming mattress
	Fluid warmers and warm liquids
	Temperature of the room
Passive methods	Isolating heat blankets
	Warm blankets
	Heat costumes

3.4 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, a state of psychomotor agitation with disorganized thinking and emotional distress 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) 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 hypoactive features being the most prominent. No specific nursing interventions exist for treating post-operative delirium, but post-operative monitoring, early mobilization and patient guidance help in preventing from injury or damage during hyperactive delirium (Harris & Chung 2013).

Residual neuromuscular block

A complication called residual neuromuscular block can lead to an extended recovery room period or a longer ward care. The effect of muscle relaxants used in general anesthesia are reversed using specific antidotes, such as neostigmine or sugammadex. The reversal of muscle relaxation needs to be monitored using the 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 has a residual neuromuscular block, or re-relaxation. This can be problematic to recognize and may cause increased morbidity and mortality in the post-operative care. (Yli-Olli 2013.)

Table 3. Symptoms of residual neuromuscular blockage

General weakness	Inability to speak, cough, swallow or smile
Inability to breathe deeply	Facial numbness
Trouble lifting head for > 5 s.	Weak hand grip
Blurred or double vision	Trouble keeping eyes open for > 5 s.

Table 3 illustrates symptoms that were tested and accounted for in a survey done by Murphy, G., Szokol, J., Avram, M., Greenberg, S., Shear, T., Vender, J., Gray, J. & Landry, E. in 2013. The symptoms listed above may be used as warning signs in detection of post-operative muscle weakness. If the residual neuromuscular block is not detected, it leads to post-operative pulmonary complications: breathing difficulties, airway obstruction, aspiration of gastric contents, tiredness and the retention of carbon dioxide. (Yli-Olli 2013.)

Peripheral nerve damage

Peripheral nerve damage, which is caused during the perioperative phase, may lead to severe complications after the operation. In the case of general anesthesia the patient is rendered immobile, which makes the patient greatly dependent 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 can 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 occurring. Most are based on usage of soft materials and the change of center of gravity on a specific body part. (Tunturi 2013.)

A common fear among patients going to surgery is awareness during general anesthesia. If a patient is aware due to an inadequate depth of anesthesia during surgery, it can cause post-operative anxiety, depression and even post-traumatic stress disorder. This is fortunately extremely rare (0.03%) and is prevented through the use of thorough monitoring and anesthetic use. (Harris & Chung 2013.)

4 Aims and purpose

The aim of this thesis was to research the post-operative complications of general anesthesia and by utilizing that information, to plan and produce a recorded video presentation for the nursing students of JAMK. The purpose of this thesis is to provide compact, informative and easy-to-use learning material. This material gives students an in-depth look at the post-operative complications of general anesthesia to improve nursing students' knowledge and expertise on the subject at hand.

5 Methodology

5.1 Evidence-based development

This thesis is carried out with methodologies based in evidence-based development. Toikko & Rantanen (2013) describe evidence-based development as the interface of research work and development work - the utilization of previous evidence-based research in development activities. This thesis is focused on the learning focal point of evidence-based development and utilizes the deep literature search methods of research work, combining them with practical means and working life aid to provide an end product for a target group. (Toikko & Rantanen 2013.) This type of thesis is divided into two parts: the written report and the end product. Reporting includes the documentation and review of the project, as well as the literature framework that is used as a basis for the end product. This method of thesis was chosen because of its beneficial nature and the intention of producing a concrete end product. (Vilkka & Airaksinen 2003.)

5.2 Target group

Target group for the video presentation was selected to be nursing students in the perioperative phase of their studies. The basic knowledge of anesthesia is given during the lectures included in their curriculum and using the video presentation they can deepen their knowledge of the post-operative complications of general anesthesia.

According to JAMK course information the perioperative and acute nursing course includes topics such as perioperative nursing process and surgical patient´s care path, with an added focus on patient safety and continuous care. The video presentation caters to these requirements as it gives the student information in regards to these points and aids in the understanding of post-operative care.

5.3 Video presentation as a learning tool

Learning is an individual experience. Everyone has his or her own way of retrieving and remembering information as efficiently as possible. These different ways of information receiving can be utilized in the creation of a learning material. A video presentation caters learners who are visual or auditory learners as it provides visual and auditory stimuli. This form of educative information provides the learner with motivational and creativity boosting material. Video presentations are used more and more in the current education and they are proven to be very effective in student's learning. (Mendoza, Caranto & David 2015.)

A video presentation in the context of this thesis, is a video of pictures and text on the subject with informative speech audio tracks designed to be such as a lecture was to be given on the subject. This method could prove to be an easy way for nursing students to learn and will prove more compelling aid than reading a guide booklet. The presentation was worded with medical jargon and

used the correct terms for educational accuracy. For this credible sources and reliable information with easily traceable referencing were used.

Slideshows and video presentations are created to demonstrate, summarize and highlight the important aspects of the issue at hand. To create a beneficial and professional video presentation for the end product, one must take in account the main ideals of a slideshow. A good slideshow is coherent and focused. This makes the presentation straight to the point and easy to understand. A guideline, basis or script must be written for the presentation to be coherent and organized. A disorganized presentation will create frustration and it can be un-motivating to watch. One slide must have a maximum of 7 to 10 rows of text, which are easy to read with suitable font sizing and to the point without extra details. (Välisalo 2015.)

5.4 Literature review

Literature review has been used to produce the end product. Literature review is a comprehensive study and interpretation of literature that is related to the topic in question (Aveyard 2010, 5-6). Purpose of the literate review is to provide accessible overview and evidence of existing literature, and also to identify the gaps on current existing literature (Polit & Beck, 2012:94). A good literature review is objectively written with little to none personal bias and contains accurate referencing. To enforce the reliability of the literature review, there must be a clear and structured search and selection strategy. (Cronin, Ryan, Coughlan 2008.)

Literature reviews are divided into traditional or narrative literature reviews and systematic literature reviews. The latter is focused on strict guidelines and protocol with a set frame for including and excluding articles, whereas the former can be more biased by the researcher's background. (Cronin et al. 2008.) The literature review in this thesis focuses on applying the concepts and principles of a systematic literature review, although disregarding the intricate protocols, which are not expected from researchers at this degree (Aveyard 2010, 16). Systematic literature review in this case consists of literature search outline planning, a systematical literature search and selection of relevant studies and information analysis of those studies. This information is then summarized and presented, keeping in mind the quality and reliability of the sources.

5.5 Literature search

The thesis was constructed to be project-based with the video presentation being the end product. To ensure the quality of the content in the video presentation a literature search was performed. This type of thorough method is suitable for gathering the needed information and resources to build an educational video presentation. Limiting the search is important in order to maintain a systematical search style. Strictly defined inclusion and exclusion criteria for the literature search aid in gathering high quality and current material, whilst ruling out the non-essential information and streamlining the presentation.

The inclusion criteria for articles and publications, used to produce the end

product were; published after 2000, peer reviewed, language either in Finnish or English, the article needs to be free and have full text, the article concerns complications of general anesthesia, the article concerns intraoperative or post-operative complications. The exclusion criteria for articles and publication used to produce the end product were; article not available for free and the article concerns pre-operative complications.

Information and data used in the creation of the end product were searched from the following digital libraries and electronic databases: Cinahl, Cochrane Library, Medic and PubMed. In addition of this, a manual search from reference lists of suitable articles was implemented. Information and data was also searched from current and reputable medical literature. Recently published nursing literature and course material was also used. Keywords for the search were chosen to be anesthesia, post-operative, general anesthesia, risk and complication. Different spelling styles were taken in account. A Boolean search method was used. Retrieved search results were glanced through, reading topics and abstracts. From these the applicable articles were selected, full text was read and they were included in the review if they met the inclusion criteria.

6 Discussion

6.1 Creation process

The topic of this thesis was approved in April 2015, but the creation process

started in January 2016. Spring of 2016 was mainly used for literature search. Writing process and the creation of the video took place during autumn of 2016. During the creation process of this thesis, timetables proved to be a problem multiple times. Both of us had many practices on the field, and sometimes it was hard to find the time or energy to start working on the thesis.

The topic was originally chosen, as it was found interesting and beneficial to learning in the deepening studies. The initial plan was to create a booklet or a guide of the post-operative complications of general anesthesia, but the video presentation - method was thought to be more comprehensive and easier to use for learning purposes than a booklet. General anesthesia and its complications were covered very briefly in perioperative lectures and a video presentation with the focus only on the post-operative complications would prove to be useful.

The video was created without funding and using currently available software and hardware. The script of the video was planned beforehand and video slides were created using the written part of the thesis as a basis to ensure easy referencing. The audio was recorded using a professional grade microphone to avoid poor quality audio, a problem seen in many learning videos. A conversational talking style was used in order to pertain a lecture – type feeling. To make the presentation simpler and more clear, we recorded only one of us talking. Background music utilized in the video was composed by one of the thesis writers, and set to a low volume for a non-distracting experience. If more time and, or funding, were to be given, the end result could have been given a graphical facelift and more immersive visual aids - A plain and simple visual style was used instead.

6.2 Ethics

A form of an ethical consideration in the creation of a thesis and an end product is plagiarism. Plagiarism is described to be the action of illicitly presenting any form of created content as your own without referencing the original content creator. Using correct referencing techniques, this form of illicit copying can be prevented and the rights of the original content creators are respected. The written part of this thesis is based on Jyväskylä University of Applied Science's project reporting instructions and ethical considerations, which include the appropriate way of referencing. Wrongly portraying information and creation of false information is also a form of fraud and not equitable. (JAMK 2013.) It is important that the video presentation does not include copyrighted content and all the content included are created for it specifically to maintain an issue free end product.

The performed literature search can raise ethical consideration through bias. Bias can be described as leaning towards certain results or searcher preferred results. In the case of the thesis and the performed literature search, a language bias can be seen, as the included results were only English and Finnish – based articles and text. Different viewpoints from other languages might have been missed due to this. Country of residence, Finland, has an impact in the real-life aspects of the study and can increase bias, as it is the only viewpoint seen and experienced by the writers of this study. (Pannucci & Wilkins 2010.)

6.3 Validity and reliability

When performing a wide literature search on a subject and aiming for reliable and educational information, the concept of validity and reliability must be taken in account. Quality of the literature found must be assessed and the information found in the literature analyzed, synthesized and disseminated. Excluding studies and articles, which are not evidence-based or include personal views enforces the validity and reliability of the study. Reference critique should be used. (Cronin et al. 2008.)

6.4 Conclusion

General anesthesia is an increasingly safe way of ensuring patient safety and comfort during surgery, but it still comes with complications that have to be recognized and deal with. As technology progresses and new techniques are introduced, the amount of complications can also decrease. (Harris & Chung 2013.)

This thesis was divided into a video presentation and a written report. The video presentation was produced for Jyväskylän Ammattikorkeakoulu (JAMK). It can be used as a learning tool for students undergoing their perioperative studies, if the responsible teacher approves the quality of the presentation. This thesis was focused on the post-operative complications and during the literature search and review it was noticed that more studies could be made on the complications of general anesthesia; pre-operative, intra-operative and post-operative all in mind.

It was also discovered, that it is not wise nor even possible, to include all possible rare complications, since it does not serve the target group of the thesis well. We both suggest a guide similar to this to be made, but with a focus on complications of local anesthesia. It would be very useful and a good research topic.

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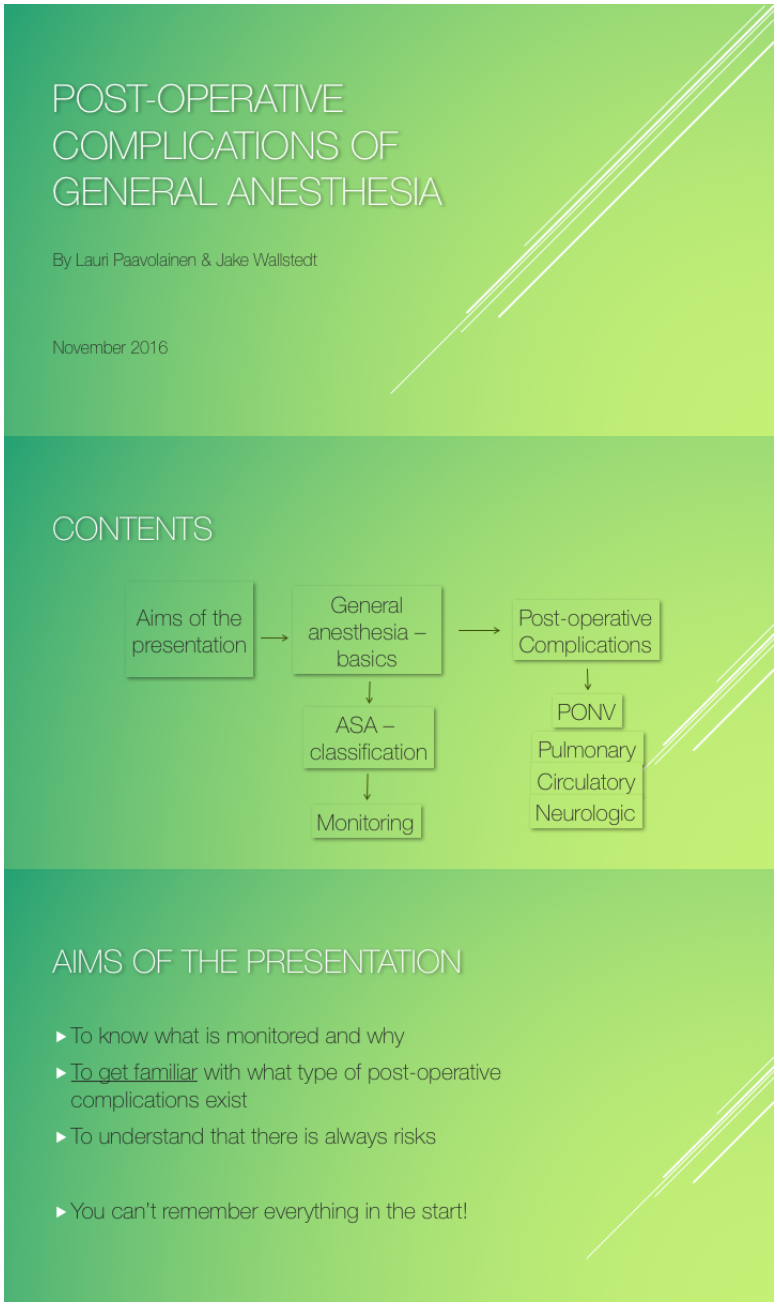
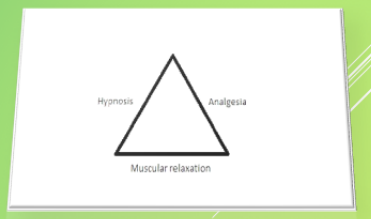
Appendices

Appendix 1. Video presentation slides



GENERAL ANESTHESIA

- What is it ?
- Foundations
  - Analgesia
  - Hypnosis
  - Muscular relaxation



GENERAL ANESTHESIA

- Different forms
  - Intravenous (TIVA)
  - Inhaled
  - Combined

ASA CLASSIFICATION SYSTEM

- American Society of Anesthesiologists classification system
- Describes condition of the patient
- Numerical scale

1	Healthy under 65 of age
2	Healthy over 65 of age, or person with mild systemic disease
3	Person with severe, non-life-threatening systemic disease
4	Person with severe systemic disease, that constantly threatens life
5	Moribund patient, who is not expected live more than 24 hours without an operation

Table 1. ASA classifications in Finland

MONITORING

- Breathing
- Circulation
- Temperature
- Fluid balance & Blood Volume
- Diuresis
- Muscle Relaxation
- Pain & Sleep

MONITORING

- Breathing
  - Risk of respiratory depression
  - SpO2, observation of breathing
  - Ventilator
- Circulation
  - Oxygenation of tissues & Hypoxia
  - BP, ECG, pulse, temperature, blood volume, diuresis
  - Non-invasive, invasive BP monitoring

MONITORING

- Temperature
  - Surgery exposes patient for loss of temperature
  - Peripheral temperature, core temperature
- Fluid balance & Blood volume
  - Goal: maintain fluid and electrolyte balance
  - Ingoing, outgoing fluid amount
  - Measuring the amount of blood loss
- Diuresis
  - Catheterization

MONITORING

- Muscle relaxation
  - Induction, reversing, upkeep
  - Peripheral nerve stimulation - TOF (train-of-four)
- Pain & Sleep
  - Optimal hypnosis and analgesia
  - Vitals and BIS

POST-OPERATIVE COMPLICATIONS

POST-OPERATIVE NAUSEA AND VOMITING (PONV)

- Most common minor post-operative complication

Why?
- Risk factors: background, surgery, medication
- Patient factors: gender, previous PONV, age, etc.
- Volatile anesthetic agents

- Prevention and treatment:
  - Antiemetic medicine
  - Fluid treatment

PULMONARY COMPLICATIONS

- Referred as PPCs.

- Risk factors:
  - ASA
  - Age
  - Existing respiratory conditions → COPD, smoking
  - Diabetes, obesity
  - Medication

PULMONARY COMPLICATIONS

Hypoventilation

- Breathing inadequate: Lower O2 levels + higher CO2 levels

Why?
- Fluid overload, too low breathing frequency
- Respiratory illness, machine error

Changes?
- Observing the patient, SpO2, ventilator monitoring
- Hypoxemia/hypoxia, delirium, wound infection risk ↑

Treatment?
- Oxygen therapy + taking care of underlying condition

PULMONARY COMPLICATIONS

Atelectasis

- The collapse or impaired functioning of a lung

Why?
- Changes in gas pressure and absorption
- Bronchial obstruction, Pneumothorax

Changes?
- Coughing, chest pain, difficulty in breathing
- Decreased inhaled oxygen volume

Treatment?
- Acute: pleural drain, suctioning
- Mild: physiotherapy & breathing exercises

PULMONARY COMPLICATIONS

Aspiration of gastric contents

- The contents of the patient's stomach rise up from the esophagus and end up in the trachea.

Why?
- Lack of fasting, emergency surgery
- Heavy sedation → Cannot control swallowing

Changes?
- Difficulties in breathing, SpO2 + monitoring
- Acute lung damage, pneumonia

Treatment?
- Securing airways
- Treating the damage caused

PULMONARY COMPLICATIONS

Bronchospasm

- contraction of smooth muscles in the bronchus

Laryngospasm

- the full closure of the vocal cords muscles.

Why?
- Inhaled irritants
- Intubation, extubation

Changes?
- Couching, wheezing
- Complete halt of spontaneous breathing

Treatment?
- Bronchodilators
- Securing the airways (mechanically, pressure)

PULMONARY COMPLICATIONS

Pulmonary edema

- Fluid accumulation in the lungs

Why?
- Vascular tissue damage, pressure change, aspiration
- Heart failure

Changes?
- Overwhelming symptom is difficulty in breathing

Treatment?
- Mechanical ventilation (intubation if needed)
- Treatment of the underlying cause (+further care)

CIRCULATORY COMPLICATIONS

Hypotension

- Decreased blood pressure

Why?
- Different factors either in combination or alone
- Cardiac output↓, systemic vascular resistance↓

Factors?
- Hypovolemia, vasodilation, arrhythmias, reduced myocardial contractility

Treatment?
- Treatment of the underlying factors

CIRCULATORY COMPLICATIONS

Hypovolemia

▸ Decreased blood volume

Why?
- Intra or post-operative bleeding
- Fluid loss

Changes?
- Tachycardia, inadequate urine output, hypotension
- Reduced peripheral perfusion, low hemoglobin

Treatment?
- Oxygenation, IV fluids (with pressure if needed)
- Blood transfusion

CIRCULATORY COMPLICATIONS

Arrhythmias

▸ Irregularities in the heartbeat

Why?
- Anesthetic agents, cardiovascular diseases
- Age, ASA, electrolyte imbalances

Changes?
- Unnecessary stress to the heart, ischemia
- Preventive measures are important

Treatment?
- Drugs in severe cases, cardioversion
- Usually they pass on their own

CIRCULATORY COMPLICATIONS

Reduced myocardial contractility

▸ Heart muscle does not contract properly

Why?
- Ischemic heart diseases
- -> lack of blood supply for the heart

Changes?
- Tachycardia, poor peripheral perfusion, distended neck veins, triple rhythm → failure of left ventricle

Treatment?
- Oxygenation, fixing position, monitoring
- May require use of vasodilators with inotropes

CIRCULATORY COMPLICATIONS

Hypothermia

▸ Low core temperature of the patient

Why?
- Anesthesia -> deactivated thermoregulation
- Exposure, evaporation, vasodilation, unwarmed fluids

Changes?
- Unwanted cardiac events, wound infection risk ↑
- Prolonged recovery

Treatment?
- Treated with active or passive methods

CIRCULATORY COMPLICATIONS

Hypothermia

Active methods	Air warming machines and blankets
	Warming mattress
	Fluid warmers and warm liquids
	Temperature of the room
Passive methods	Isolating heat blankets
	Warm blankets
	Heat costumes

Table 1. Active and passive methods of warming

CIRCULATORY COMPLICATIONS

Hypertension

- High blood pressure

Why?
- Existing condition, hypothermia, hypoxemia
- Hypercapnia, confusion, pain

Changes?
- Can result in serious neurological and cardiovascular complications

Treatment?
- Treated with correcting these conditions
- Vasodilators or beta-blockers might be needed

NEUROLOGIC COMPLICATIONS

Post-operative cognitive dysfunction

- Including agitated emergence, emergence delirium

Why?
- Anesthetic agent use
- Post-operative confusion

Changes?
- Can cause discomfort, agitation and even physical injury

Treatment?
- No specific nursing interventions → Monitoring

NEUROLOGIC COMPLICATIONS

Residual neuromuscular block

- Effect of muscle relaxants is prolonged

Why?
- Patient reaction to antidotes
- Unnoticed through TOF monitoring

Changes?
- Recognition through TOF or observation
- Breathing difficulty, airway obstruction, aspiration etc.

Treatment?
- Managed through TOF monitoring + antidote use

NEUROLOGIC COMPLICATIONS

Residual neuromuscular block

General weakness	Inability to speak, cough, swallow or smile
Inability to breathe deeply	Facial numbness
Trouble lifting head for > 5 s.	Weak hand grip
Blurred or double vision	Trouble keeping eyes open for > 5 s.

Table 1. Symptoms of residual neuromuscular blockage

NEUROLOGIC COMPLICATIONS

Peripheral nerve damage

- Stretched or compressed nerve results in nerve damage

Why?
- Immobilization →
- Patient positioning

Changes?
- Nerve damage
- Pain

Treatment?
- Prevented intraoperative through position change and soft material use

NEUROLOGIC COMPLICATIONS

Awareness

- Being awake during general anesthesia

Why?
- Inadequate depth of anesthesia

Changes?
- Post-operative complications: anxiety, depression and PTSD

Treatment?
- Proper depth of anesthesia
- Extremely rare but a common fear

THANK YOU FOR LISTENING!