

General Anesthesia: Observing and Monitoring the Post-operative Complications

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Abstract

The aim of this research was to analyze the post-operative complications of general anesthesia and by utilizing that information, to plan and produce a comprehensive detailed layout of the literature related to the subject investigated. More than 200 studies were surveyed, and the data collected was organized with a systematic layout of the observing and monitoring processes of the post-operative general anesthesia complications. The study concluded that post anaesthetic observations and monitoring are an essential requirement for patient assessment and the recognition of clinical deterioration in post-operative patients. There is disparity in the literature as to what constitutes 'standard' routine post anaesthesia orders, so in line with the observation and continuous monitoring guidelines.

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1.1 Introduction

Postoperative patients must be observed, monitored and assessed closely for any deterioration in condition and the relevant postoperative care plan or pathway must be implemented. And by definition; postoperative care is the management of a patient after surgery. This includes care given during the immediate post-operative period, both in the operating room and post-anesthesia care unit (PACU), as well as during the days following surgery. Recovery from anaesthesia is the time from the end of surgery to when the patient is alert and physiologically stable. The anesthetist is ultimately responsible for the care of the patient during this period. For the majority of patients, recovery from anaesthesia is uneventful however when postoperative complications occur, they may be sudden and life threatening (Fearon, Ljungqvist, Von Meyenfeldt, Revhaug, Dejong, Lassen & Kehlet, 2005). The post anaesthetic care unit (PACU) or recovery must be in close proximity to the operating rooms, have dedicated staff, appropriate monitoring and the drugs and equipment for routine and emergency care. All patients

recovering from anaesthesia should be nursed in a PACU. All patients will benefit from supplemental oxygen. No patient should be left alone after anaesthesia. The main functions of the PACU are:

- 1- Monitor the patient's vital signs more closely than is possible on the ward
- 2- Optimize the patient's analgesia and treat postoperative nausea and vomiting
- 3- Quickly detect and treat early complications after surgery and anaesthesia.

Post anaesthetic observations and monitoring are an essential requirement for patient assessment and the recognition of clinical deterioration in post-operative patients. There is disparity in the literature as to what constitutes 'standard' routine post anaesthesia orders, so in line with the observation and continuous monitoring guidelines (Merry, Cooper, Soyannwo, Wilson & Eichhorn, 2010).

Postoperative complications related to anesthesia cover a wide spectrum of severity from mildly distressing with no long-term sequelae to death or permanent disability. It has been suggested that several factors contribute to postoperative morbidity and length of hospital stay, including comorbidities and their pre-operative control, the surgical stress response, postoperative organ dysfunction, pain, poor nutrition and sleep disturbances (Kehlet & Dahl, 2003).

Anesthetic technique and medications used may also contribute to postoperative complications. Common complaints include nausea and vomiting, surgical pain, sore throat, headache, drowsiness and dizziness, dental damage, peripheral nerve injury, and superficial thrombosis. Awareness during anesthesia is a very rare but potentially devastating complication of anesthesia.

The development of safer anesthetic agents, modes of delivery and improvements in patient monitoring and pain management over the past few decades have translated into a reduction in anesthetic risk. However, although there has been a decline in mortality and major morbidity rates, the incidences of minor and more common complications have not changed significantly. These complications show a strong correlation with overall patient satisfaction with their anesthetic experience, and may result in enough patient discomfort to justify changes in practice. Therefore, it is important for anesthesiologists to monitor clinical outcomes and use the information gained to improve quality of care (Tennant, Augier, Crawford-Sykes, Ferron-Boothe, Meeks-Aitken, Jones, & Harding-Goldson, 2012).

A post-operative pulmonary complication is "any pulmonary abnormality that produces identifiable disease or dysfunction that is clinically significant and adversely affects the clinical course of the patient" (Blanchard, 2006).

Post-operative complications from general anesthetics include: suppressed diaphragmatic movement, decreased response by the ventilatory system, atelectasis (alveolar collapse), perfusion abnormalities, decreased muco-ciliary transport making the patient susceptible to infection, hypoxemia, respiratory failure and respiratory distress syndrome (Kanat, Golcuk, Teke & Golcuk, 2007).

1.2 Problem statement

postoperative care is the management of a patient after surgery. This includes care given during the immediate postoperative period, both in the operating room and post-anesthesia care unit (PACU), as well as during the days following surgery. Postoperative care involves assessment, diagnosis, planning, intervention, and outcome evaluation. The extent of postoperative care required depends on the individual's pre-surgical health status, type of surgery, and whether the surgery was performed in a day-surgery setting or in the hospital. Patients who have procedures done in a day-surgery center usually require only a few hours of care by health care professionals before they are discharged to go home. If post-anesthesia or postoperative complications occur within these hours, the patient must be admitted to the hospital. Patients who are admitted to the hospital may require days or weeks of postoperative care by hospital staff before they are discharged.

The problem of the study lies in estimating and analyzing the observation and monitoring protocols for the post-operative complications of general anesthesia, and analyze each of the post-anesthesia complications.

1.3 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, Rosenberg 2014).

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.

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. 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).

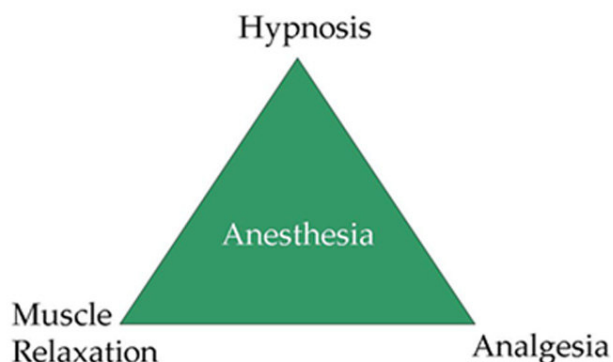


Figure (1): The triangle of general anesthesia

1.3.1 Forms of general anesthesia

1.3.1.1 Intravenous anesthesia

Intravenous anesthesia (see figure 2), 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. The goal is to achieve amnesia, sedation and sleep with the dose. This form of anesthesia is also known as TIVA (total intravenous anesthesia), because it does not use any inhalable hypnotics (Aantaa & Scheinin 2014).

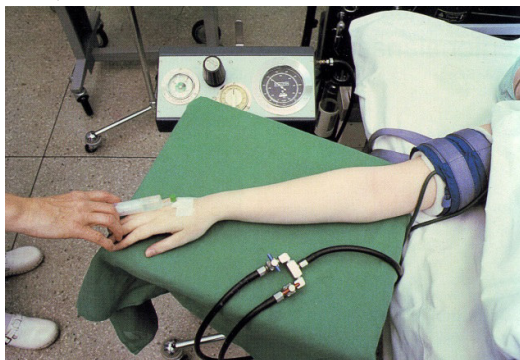


Figure (2): Intravenous anesthesia

1.3.1.2 Inhalation anesthesia

Inhalation anesthesia (see figure 3) 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).



Figure (3): Inhalation anesthesia

1.3.1.3 Combined anesthesia

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 7 anesthetics, and then kept up with inhalable anesthetics and intravenous opioids. (Aantaa & Scheinin 2014).

1.4 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 4 shows an Infinity Delta monitor with monitored values depicted as graphs and numerical values. (Lukkari et al 2013).



Figure (4): Infinity Delta monitor

To ensure patient safety, monitoring is used in general anesthesia for the following criteria, as shown in table (1) below.

Table (1): Monitoring criteria in general anesthesia

Monitoring criteria	Mechanism
Breathing	Breathing is closely monitored and observed, because in every general anesthesia the risk of respiratory depression is always present. 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.
Circulation	Circulation is monitored to ensure sufficient oxygenation for tissues and to prevent hypoxia. During general anesthesia patient's circulation is monitored by measuring blood pressure, pulse, temperature, blood volume and diuresis. Blood pressure can be monitored either by non-invasive or invasive method, where the invasive method requires an arterial cannula.
Temperature	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 un-warmed intravenous fluids, evaporation from within surgical incisions, vasodilation caused by anesthesia and exposure of skin to make needed preparations.
Fluid balance and blood volume	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.
Diuresis	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. To monitor the amount of diuresis, a urine catheter is used.
Muscle relaxation	Muscle relaxation observation is needed during the induction, reversing and in the upkeep of hypnosis. Before intubation or extubating is done, proper relaxation is essential to ensure safety of the procedure.
Pain and sleep	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.

1.5 Post-operative complications involving general anesthesia

1.5.1 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. 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, and figure (5) shows the whole (PONV) factors.

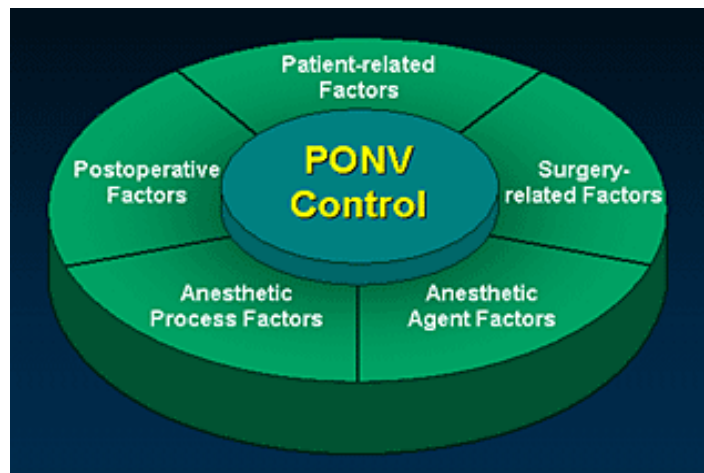


Figure (5): The whole (PONV) factors

1.5.2 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 16 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).

Table (2) below shows the Post-operative pulmonary complications (PPCs):

Table (2): Post-operative pulmonary complications (PPCs)

Complications	Description
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.
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.
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 coughing him or herself.
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.

1.5.3 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).

And table (3) below shows the Post-operative Circulatory complications:

Table (3): Post-operative Circulatory complications

Complications	Description
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.
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.
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.
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.
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.
Hypothermia	Post-operative hypothermia appears to develop more likely in patients that have undergone surgery with general anesthesia than with spinal anesthesia. 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.

1.5.3 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 25 or violent. (Card, Pandharipande, Tomes, Lee, Wood, Nelson, Graves, Shintani, Ely & Hughes, 2015).

And table (4) below shows the Post-operative neurological complications:

Table (4): Post-operative neurological complications

Complications	Description
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.
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.

1.6 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.

In the first 24 hours and after the hospitalized patient transfers from the PACU, procedures should assess the patient again, using the same previously mentioned categories. If the patient reports "hearing" or feeling pain during surgery (under anesthesia) the observation should not be discounted. The anesthesiologist or nurse anesthetist should discuss the possibility of an episode of awareness under anesthesia with the patient. Vital signs, respiratory status, pain status, the incision, and any drainage tubes should be monitored every one to two hours for at least the first eight hours. Body temperature must be monitored, since patients are often **hypothermic** after surgery, and may need a warming blanket or warmed **IV fluids**. Respiratory status should be assessed frequently, including assessment of lung sounds (auscultation) and chest excursion, and presence of an adequate cough. Fluid intake and urine output should be monitored every one to two hours. If the patient does not have a urinary catheter, the bladder should be assessed for distension, and the patient monitored for inability to urinate. The physician should be notified if the patient has not urinated six to eight hours after surgery. If the patient had a vascular or **neurological** procedure performed, circulatory status or neurological status should be assessed as ordered by the surgeon, usually every one to two hours. The patient may require medication for nausea or vomiting, as well as pain.

After the initial 24 hours, vital signs can be monitored every four to eight hours if the patient is stable. The incision and dressing should be monitored for the amount of drainage and signs of infection. The surgeon may order a dressing change during the first postoperative day; this should be done using sterile technique. For home-care patients this technique must be emphasized.

The hospitalized patient should be sitting up in a chair at the bedside and ambulating with assistance by this time. Respiratory exercises are still be performed every two hours, and incentive spirometry values should improve. Bowel sounds are monitored, and the patient's diet gradually increased as tolerated, depending on the type of surgery and the physician's orders.

The patient should be monitored for any evidence of potential complications, such as leg edema, redness, and pain (deep vein thrombosis), shortness of breath (pulmonary embolism), dehiscence (separation) of the incision, or ileus (intestinal obstruction). The surgeon should be notified immediately if any of these occur. If dehiscence occurs, sterile saline-soaked dressing packs should be placed on the wound.

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