The attitude of anesthesia assistants towards Artificial Intelligence-assisted patient monitoring in the Operating Room

Karlijn Joosten

Impact Law, 2022

TU Delft

The attitude of anesthesia assistants towards Artificial Intelligence-assisted patient monitoring in the Operating Room

Using the knowledge on their attitude and motivation to create an educational module that supports anesthesia assistants in their awareness and understanding of the impact of AI-assisted monitoring

By

Karlijn F. Joosten

in partial fulfilment of the requirements for the degree of

Master of Science

in Communication Design for Innovation

at the Delft University of Technology,

to be defended publicly on Thursday June 23, 2022.

TU Delft, Department of Science Education and Communication & Biomechanical Engineering

Supervisors: Drs. C. Wehrmann

Dr. J. J. van den Dobbelsteen

Dr. M. van der Sanden

TU Delft

Summary

Research on the possibilities to use Artificial Intelligence (AI) at the Operating Room (OR) is rising, although there is no implementation yet. AI-assisted monitoring could provide support to anesthesia assistants in their task of patient monitoring, by making predictions on the future occurrence of deviating events in the vital parameter values of the patient. As AI-assisted monitoring would come close the profession of anesthesia assistants, this explorative, qualitative research investigates the attitude of anesthesia assistants towards the use of AI in their task of patient monitoring. Furthermore, it investigates the motivational factors that are important for their motivation in their monitoring task as well as the expected impact of AI on their motivation. This design-based research subsequently describes how these results are incorporated into the development of an educational module about AI and motivation for anesthesia assistants. Gaining as well as giving insight in the motivation of anesthesia assistants is important, as their motivation is of impact on their professional behaviour while their decisions and actions are directly related to the safety of the patient.

Through literature research and semi-structured interviews, it was found that among anesthesia assistants there is little knowledge on the possibilities of AI at the OR, but that their attitude towards AI-assisted monitoring is positive as long as only suggestions are given. Only two out of eight anesthesia assistants are cautiously positive towards the possibility of AI to automate the monitoring process. Furthermore, it was found that the motivational factors of autonomy, relatedness, competence, self-efficacy, and self-actualisation are all important to very important in the motivation of anesthesia assistants. Overall, none of these factors stands out in being most or least important. The expected impact of AI on these motivational factors among anesthesia assistants varies from negative to positive and is highly dependent on the form of AI-assisted monitoring. As various forms of interrelatedness between all these motivational factors are identified by the anesthesia assistants, specific to their working practice and environment, the impact on one motivational factor might indirectly also impact others.

These results on attitude and motivation are incorporated in the design of an educational module for anesthesia assistants. The module consists of two parts. One part regarding AI-assisted monitoring and one part regarding the motivational factors that are important for their motivation and the impact of AI on motivation. Design requirements by the anesthesia assistants, as well as an expert validation by an anesthesia educator, are used to finalise the design of the module. This module can help anesthesia assistants to develop awareness and understanding of how AI-assisted monitoring, in the form of giving suggestions, can support them in their patient monitoring task. Furthermore, it helps them to develop awareness and understanding on their own motivation and the impact that the use of AI-assisted monitoring may have on their motivation, guiding them towards becoming deliberate professionals.

List of abbreviations

AI	Artificial Intelligence
BIS	Bispectral Index
BMI	Body Mass Index
ECG	Electrocardiogram
EEG	Electroencephalogram
EMG	Electromyography
LUMC	Leiden University Medical Center
OR	Operating Room

Table of contents

1. Introduction

1.1. The potentials of AI to support anesthesia assistants at the OR

Artificial Intelligence (AI) uses the combination of computer science and large datasets to simulate the human thinking in reasoning and learning, and with that solve problems and make decisions (Rong et al., 2020). Machine learning is one of the subfields of AI, in which algorithms are used to identify patterns in data and use those to make predictions (Shaw et al., 2019; McGrow, 2019). This way, the information from the datasets is used to estimate desired, but lacking, information (Shaw et al., 2019).

The research on the possibilities of AI in healthcare is on the rise (Koens & Vennekens, 2021; Yu, Beam & Kohane, 2018). However, in contrast to other disciplines, such as AI-based digital assistants in smartphones, AI in healthcare still is in its development phase (Maedche et al., 2019; Birkhoff, van Dalen & Schijven, 2021; Ngo et al., 2021; Kelly et al., 2019). There are many possibilities for clinical implementation of AI in healthcare, as more and more data are collected, but there are also still many barriers, such as issues on the use of privacy-sensitive patient data, distrust of AI by clinicians, and the lack of explainability on the choices made by the AI system (Hengstler, Enkel & Duelli, 2016; Stewart, Sprivulis & Dwivedi, 2018; Park et al., 2020). At this moment, the development of AI in healthcare focuses mainly on medical-image diagnosis, where machine learning methods are used to recognise abnormalities in radiological images (Yu, Beam & Kohane, 2018). The algorithm learns from thousands of examples of radiological images that have already been analysed, meaning that abnormalities already were detected and labelled. The output of the training of prediction algorithms with these data is a machine learning model that is able to detect abnormalities in new radiological images (Yu, Beam & Kohane, 2018; McGrow, 2019; Tang et al., 2021).

When looking at the operating room (OR), much research is being performed on the use of AI at the OR, but no applications are in practice yet (Birkhoff, van Dalen & Schijven, 2021). For anesthesia, AI could especially play a role in increasing patient safety through the prediction of risk factors in patient monitoring (Srinivasa et al., 2018; Stewart, Sprivulis & Dwivedi, 2018; Tang et al., 2021). In the monitoring of patients, in which anesthesia assistants are mainly involved, AI could play a role by precisely surveilling the values of the vital parameters of the patient during surgery and warning early in case of upcoming worrying deviations. For example, machine learning could be used to predict an upcoming low blood pressure, hypotension, based on the arterial pressure waveform of the patient 15 minutes before its occurrence (Hatib et al., 2018). The machine learning model detects arterial pressure waveform alterations by training the algorithm with thousands of earlier records of patients during surgery in which occasionally a hypotension event occurred (Hatib et al., 2018).

AI could also further improve digital technologies in the OR, like the transformed electroencephalogram (EEG) monitor that measures the bispectral index (BIS) to monitor the depth of anesthesia of the patient at the OR (Rush, Celi & Stone, 2019). This BIS-monitor gives the anesthesia assistant feedback concerning the amount of hypnotics to be administered (Mathur et al., 2021). However, at the moment the BIS-monitor has a processing time delay of around 30 seconds, with possible clinical implications (Mathur et al., 2021; Ferreira et al., 2019). Optimalisation of the BIS monitor by AI could provide support in the patient monitoring task of anesthesia assistants. The more as the workload of anesthesia assistants in healthcare is considered high and there are major personnel shortages (Dreessen & Hoorn (LVO), 2012; Capaciteitsorgaan, 2018; Nederlandse Vereniging van Anesthesiemedewerkers, 2014; Lupke, 2019). AI in the OR could potentially play a role in the relieve of the workload of anesthesia assistants.

The use of AI at the OR could provide support in the patient monitoring task of anesthesia assistants, by predicting abnormal events in the vital values based on data of previous surgeries (Amann et al., 2020). This way, AI could contribute to patient safety by reducing serious incidences and complications (Hatib et al., 2018), as well as assist anesthesia assistants in treatment decisions (Amann et al., 2020; Asan, Bayrak & Choudhury, 2020).

1.2. Problem description

Using AI could thus be of added value for patient monitoring at the OR by predicting complications before their occurrence, which helps anesthesia assistants to monitor patients and make quick and correct treatment decisions. However, there is insufficient knowledge about the needs and preferences of the users, in this case the anesthesia assistants, while they are the ones that will have to work with the developed AI in the future (Matheny, Israni & Ahmed, 2018). Users should be incorporated in the development and clinical

implementation of AI at the OR. So, it is important to look into the attitude of the anesthesia assistants towards AI: how they see the possibilities of AI in their patient monitoring task and where they see opportunities or would prefer support or acquisition. This knowledge is essential for mutual awareness and future collaboration between healthcare personnel and AI developers (Nederlandse Vereniging van Anesthesiemedewerkers, 2014; Asan, Bayrak & Choudhury, 2020).

Furthermore, motivation of anesthesia assistants in their work, and more specifically in their task of patient monitoring, is an important point of attention in the use of AI at the OR. AI is not a simple technology that adds as another device to the job of anesthesia assistants. AI has the potential to take-over parts of the profession of anesthesia assistants and thus can have a significant impact on their motivation. Because the motivation of anesthesia assistants in their job task influences the choice to continue or leave their job, it is helpful to gain as well as provide insight into their motivation and the impact of AI on their motivation (Koch et al., 2014). Additionally, this insight can be used to future develop and implement AI in a way that it ensures that the important factors that positively influence motivation are maintained or improved.

To summarise, the main problem is the current lack of knowledge about the attitude of anesthesia assistants towards AI-assisted monitoring, the factors that are of influence on their motivation in patient monitoring and the possible effect of the use of AI on these motivational factors.

1.3. Research aim

This study aims to contribute to the identification of the attitude of anesthesia assistants towards the use of AI, the motivational factors important for their motivation in their patient monitoring task, and the possible effect of AI-assisted monitoring on these motivational factors.

A second aim of this study is developing the contours of an educational module, including learning goals, on the topics of AI and motivation for anesthesia assistants. Working towards a more thorough awareness and understanding of AI and its possibilities within patient monitoring among anesthesia assistants, as well as awareness on their motivation and the impact of AI on motivation, is aimed to be reached with this educational module. The aim of the educational module is not to convince anesthesia assistants of how good AI is, neither to motivate them, but to give insight in how AI works as well as in their own motivation and the possible impact of AI on their motivational factors.

1.4. Research questions

Based on the proceeding problem description and research aims, a central research question is formulated to lead this explorative, qualitative research:

RQ: “How can knowledge on the attitude of anesthesia assistants towards Artificial Intelligence (AI) and their motivation in their task of patient monitoring in the Operating Room (OR) be used to build an educational module that could support anesthesia assistants in their awareness and understanding of the impact of AI-assisted monitoring?”

Five sub-questions, each covering a part of the central research question, guide towards the answer to this central research question:

- SQ1. What characterises the working environment of anesthesia assistants and what are their tasks and responsibilities at the OR?
- SQ2. What AI possibilities are there in the patient monitoring task of anesthesia assistants, and the prediction of risk factors?
- SQ3. What is the perception and attitude among anesthesia assistants on AI possibilities in monitoring, and what are their preferences in the use of AI-assisted monitoring?
- SQ4. How could the use of the AI possibilities affect the anesthesia assistants’ motivation in their task of patient monitoring?
- SQ5. How can the knowledge on attitude and motivation of anesthesia assistants be used to build an educational module to support anesthesia assistants in their awareness and understanding of the impact of AI in their monitoring task?

To answer the sub-questions and with that the main question of this research, a design-based research approach is used for this qualitative, explorative research. A combination of both literature research and semi-structured interviews with anesthesia assistants are used and performed. A visualisation of the coherence of

the sub-questions and central research question is visible in Figure 1. The research into the target group of anesthesia assistants and the research into the possibilities of AI in monitoring and predicting risk factors, in sub-questions 1 and 2, form the basis of this research. This way, anesthesia assistants can be asked proper questions about their attitude towards and their preferences in introducing these AI possibilities in their task of patient monitoring for sub-question 3. A subsequent investigation of the motivational factors that are found important in the anesthesia assistants' monitoring task (part of sub-question 4) is needed to further research how these motivational factors are related to the preferences of anesthesia assistants (results of sub-question 3), and with that how the use of AI could affect the anesthesia assistants' motivation. In sub-question 5, the results of the previous sub-questions are used in the development of the contours of an educational module for anesthesia assistants around the topic of AI and their motivation in patient monitoring. This way, the central research question can be answered.

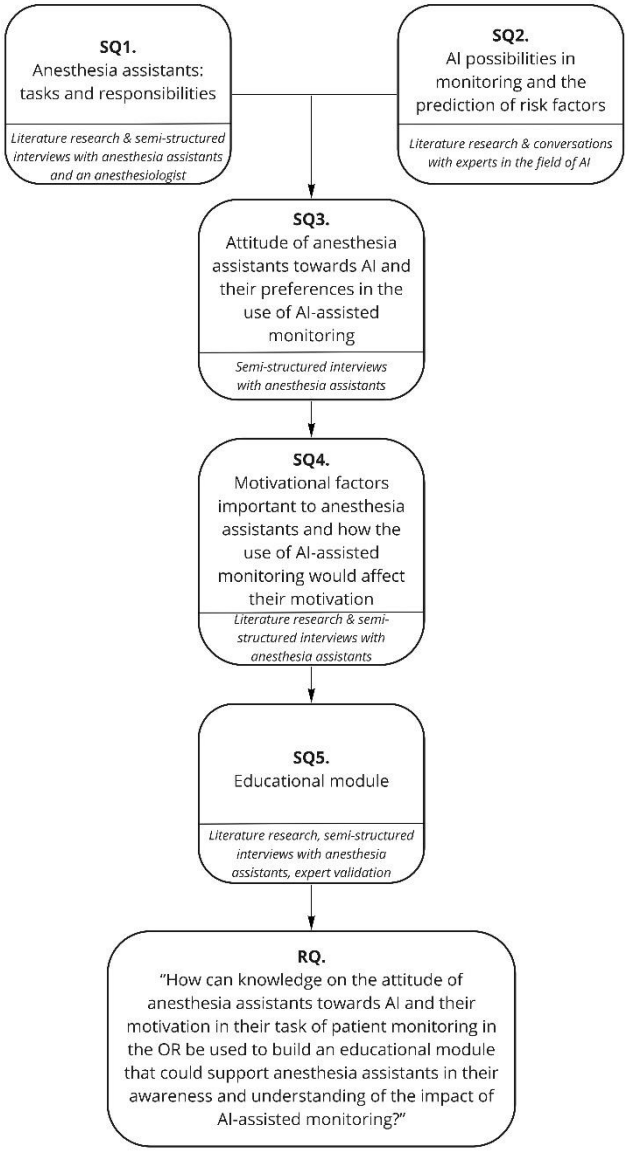


Figure 1. Visualisation of the coherence of the sub-questions and central research question, including the used methods per sub-question. (Own visualisation).

1.5. Research outline

In Chapter 2, the Theoretical Framework is presented. This Theoretical Framework forms the theoretical basis for the research on attitude and motivation, as well as for the educational module. The Theoretical Framework is followed by the Methodology in Chapter 3, in which the set-up of the research is described. This chapter includes the description of the performed literature research, as well as the semi-structured interviews that were performed with anesthesia assistants. Here, also the concepts of the Theoretical Framework are turned into measurable variables and linked to the interview research questions in the Operationalisation table. Thereafter, in Chapter 4 and 5, the context of this study is described. The working environment and tasks of anesthesia assistants, and the contemporary developments and possibilities in AI-assisted monitoring are respectively discussed. Chapter 6 contains the results of the research on the perception and attitude of the anesthesia assistants, and Chapter 7 the results of the research on their motivation. In Chapter 8, the educational module that could provide support to anesthesia assistants in learning about AI and their motivation is worked out. The chapter on the educational module is followed by the Conclusion, in Chapter 9, where the answers on the sub-questions and central research question are given. In the Discussion and recommendations in Chapter 10, the theoretical framework, research design, results, educational module, and relevance of this study are discussed, and recommendations for further research are given.

2. Theoretical Framework

This chapter contains the theoretical framework, which explains the key concepts and theories that are used as basis for this study and provide support in the answering of the specified research sub-questions. This theoretical framework is built up by different subsections. In Section 2.1, an overall picture is sketched of the situation and the positioning of this research. In Section 2.2, the theoretical basis for sub-question 3 is provided, of how anesthesia assistants see the AI possibilities in monitoring and how they would like to see the implementation of AI in the nearby future, by zooming in on the topic of 'Attitude towards and behavioural intention to use AI-assisted monitoring'. Section 2.3 forms the theoretical basis for the motivational model for sub-question 4, to investigate which motivational factors are most important for anesthesia assistants in their motivation regarding their monitoring task, and later on investigate the impact of AI on these motivational factors. Hence, Section 2.3 elaborates on the topic of 'Motivation in patient monitoring'. Finally, in Section 2.4, the theoretical basis for sub-question 5 regarding the educational module for anesthesia assistants is described. The topic 'Learning about AI-assisted monitoring' overarches the theory behind learning in this practice context.

2.1. Positioning of this research

This research considers the context of anesthesia assistants working at the OR performing their task of patient monitoring, and the potential use of AI-assisted monitoring in this task. This is viewed from a theoretical perspective based on communication theories focusing on psychological and sociological aspects.

Theories regarding attitude and behavioural intention will theoretically support the research on the attitude of anesthesia assistants towards the use of AI-assisted monitoring. Anesthesia assistants try to maintain the patient wellbeing and safety through the monitoring of the vital parameter values of the patient, and AI-assisted monitoring applications are being developed for the anesthesia field to improve this patient monitoring (Birkhoff, van Dalen & Schijven, 2021; Mathis, Kheterpal & Najarian, 2018). Research on attitude and behavioural intention towards the use of AI-assisted monitoring is important, as anesthesia assistants eventually will have to use these AI-assisted monitoring applications in their work and AI-assisted monitoring may even replace parts of their task.

Furthermore, motivation theories are investigated in order to theoretically justify the findings of the research on the motivational factors that are important for the motivation of anesthesia assistants, as well as the findings on the research towards the potential impact of AI-assisted monitoring on motivation. Motivation in patient monitoring is important to sustain the attention and prevent decrement of vigilance of the anesthesia assistant, ensuring that the monitoring is performed as best as possible (Oken, Salinsky & Elsas, 2006).

Finally, theories and models on learning form the theoretical basis for the set-up of the educational module, as well as for the learning goals that will be part of the module.

2.2. Attitude towards and behavioural intention to use AI-assisted monitoring

The behaviour of users in the use of new technologies can be described by several theories. The *Theory of Reasoned Action* is the most powerful theory for user behaviour prediction according to Marques, Villate & Carvalho (2011) and Khan & Qudrat-Ullah (2021) (Marques, Villate & Carvalho, 2011; Khan & Qudrat-Ullah, 2021). According to the Theory of Reasoned Action, the behaviour of a person is determined by the intention for the performance of the behaviour (Fishbein & Ajzen, 1977). This behavioural intention is subsequently influenced by the attitude of the person towards the behaviour and the subjective norm (Fishbein & Ajzen, 1977). The latter relates to the beliefs of the person about the approval or disapproval of the behaviour by people that are important to that person (Buschmann, Chen & Hauer, 2020).

In the *Technology Acceptance Model*, this behavioural intention towards certain behaviour is described as the behavioural intention to use a technology, with the behaviour being the use of the technology (Davis, 1989). The attitude towards using the technology affects the behavioural intention to use the technology. The two factors of perceived usefulness and perceived ease of use affect the attitude of the person towards technology (Davis, 1989). Next to the indirect impact of the perceived usefulness and perceived ease of use on behavioural intention to use, also a direct impact of perceived usefulness on behavioural intention is present (Davis, 1989).

The combination of these two theories is used to describe the link between attitude of anesthesia assistants towards the use of AI-assisted monitoring and the behaviour of anesthesia assistants to use it in practice, taking into account the extra factors that impact this effect, see Figure 2. Although the Technology Acceptance Model is a model designed to assess the behavioural intention to using new technologies by a user, based on their attitude, AI is not just a simple technology. But, as there are no specific models on the behavioural intention or acceptance of AI, the Technology Acceptance Model is the most useful in this context to determine the behavioural intention of the future users, anesthesia assistants, on the use of AI-assisted monitoring.

The anesthesia assistants' behaviour to use AI as technology is thus determined by their intention for the behaviour, with behavioural intention in this case the willingness of the anesthesia assistant to endeavour to perform the behaviour of using AI in practice (Holden & Karsh, 2010). The three factors that influence this behavioural intention are the anesthesia assistants' attitude towards the behaviour, their subjective norm, and the perceived usefulness. The attitude and subjective norms can respectively be described as the anesthesia assistants' overall assessment and beliefs about the behaviour of using AI, and the social pressure by colleagues and people of importance/management to use or do not use AI.

The behavioural intention to use AI by the anesthesia assistant, is influenced by their attitude towards AI, which in turn is affected by the two factors of perceived usefulness and perceived ease of use. Perceived usefulness is in this context defined as the perception of the anesthesia assistant whether using AI will enhance the monitoring performance and perceived ease of use as the perception that using AI will take or take no effort and therefore whether the monitoring task will take more or less effort (Holden & Karsh, 2010). If the user considers the AI innovation as an extra burden, this will affect their attitude and intentions in using the AI innovation (Wang et al., 2021).

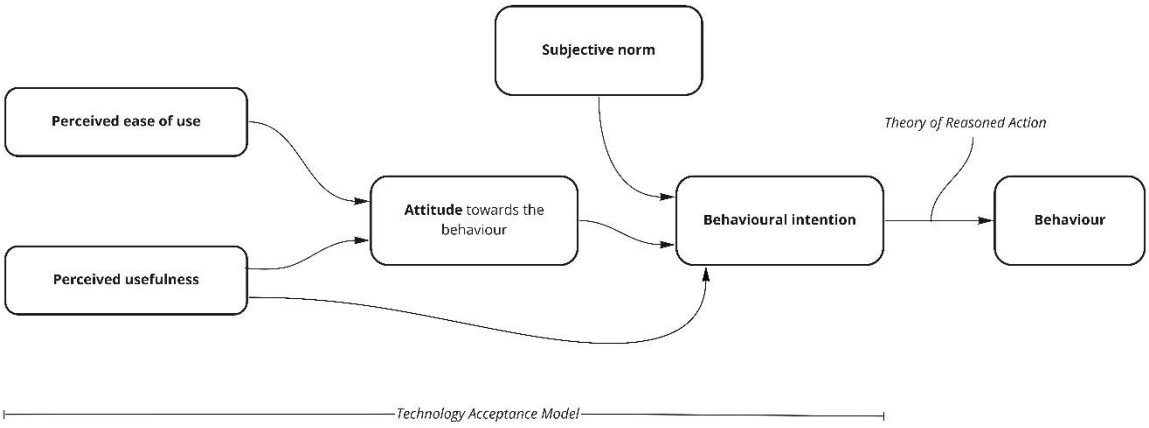


Figure 2. The behaviour to use innovations in AI-assisted monitoring by anesthesia assistants can be described by the Theory of Reasoned Action and Technology Acceptance Model (Own visualisation, interpretation based on the Theory of Reasoned Action by Fishbein & Ajzen (1977) and the Technology Acceptance Model by Davis (1989) (Fishbein & Ajzen, 1977; Davis, 1989). The behaviour of using AI-assisted monitoring by anesthesia assistants is influenced by their behavioural intention to use AI. This behavioural intention is influenced by their attitude towards the use of AI, their subjective norm, as well as the perceived usefulness. Their attitude is impacted by the perceived ease of use, as well as the perceived usefulness.

Also, other factors like amongst others motivation for the behavioural intention are of influence on the adoption of AI assisted monitoring by anesthesia assistants, but are outside the scope of this research (Taherdoost, 2018).

2.3. Motivation in patient monitoring

In addition to the thought that task-related motivation towards the monitoring task contributes to the patient well-being, anesthesia assistants' motivation and job satisfaction are also two elements that influence their decision to potentially quit their job (Koch et al., 2014). As the monitoring task is put central, the task-level motivation instead of more general motivation must be researched. Task-related motivation can be defined as the motivation to initiate a task and the perception that the task is worth pursuing (Thomson & Jaque, 2016).

Task-level motivation in monitoring is influenced by various variables, or so-called motivational factors, determining how someone approaches the monitoring task (Fernet, Chanal & Guay, 2017). These

factors are ranging from the individual, the workplace, working conditions, individual priorities, and internal psychological states (Koch et al., 2014). In this study, the focus is not on the individual priorities and internal psychological states, although these can never be filtered out completely.

All in all, is it important to find out which factors affect the motivation of anesthesia assistants, to prevent that by future development and use of AI in the monitoring at the OR, the motivation of anesthesia assistants is negatively influenced by not considering these motivational factors. For example, AI could both support autonomy of the target users or undermine it (Laitinen & Sahlgren, 2021). To determine which factors may affect the motivation of the anesthesia assistants in their monitoring task, different theories that incorporate motivation are considered. Three different theories are incorporated here that embrace intrinsic motivational factors. These theories were chosen as these theories best matched the context of intrinsic motivated behaviour of an individual to perform a certain task.

2.3.1. Self-determination theory

According to the *Self-determination theory*, humans have three essential psychological needs that are key drivers of motivated behaviour, namely autonomy, relatedness, and competence (see Figure 3) (Deci & Ryan; 1985; Deci & Ryan, 2015). Autonomy is described by the Self-determination theory as being able to provide input, act with volition, and authenticity. Relatedness is described as the connected feeling with significant others of that context as well as feeling cared for by them. The description of competence is feeling effective in satisfying the demands of the environment (Duda & Appleton, 2016; Ryan & Deci, 2000a; Ryan & Deci, 2000b).

Furthermore, this theory describes different types of motivation as a continuum from amotivation, through extrinsic motivation, to intrinsic motivation (Ryan & Deci, 2000c). Intrinsic motivation relates to someone doing something because it is intrinsically enjoyable or interesting to them, while in extrinsic motivation, someone is doing something as it results in some distinct outcome (Ryan & Deci, 2000c). Extrinsic motivation for a task can be divided into a range of forms. The closest to amotivation lies external regulation, where external demands such as rewards or punishment lead to motivation to perform the task. In consecutive order towards intrinsic motivation are introjected regulation, in which the motivation for the task is caused by guilt or contingent self-esteem, identified regulation, where the person values the goals of the task deliberately, and integrated regulation, where the values of the goal of task are incorporated in the persons own values (Cook & Artino, 2016).

In the context of anesthesia assistants at the OR, autonomy relates to the ability to have input, make decisions, and have responsibilities (Duda & Appleton, 2016). More specifically, autonomy to anesthesia assistant in the monitoring task could mean that one is able to make own choices in deviating from a protocol or carrying out medical procedures by themselves. *Relatedness* means that the anesthesia assistant feels connected with colleagues, and the multidisciplinary operating team at duty (i.e. the anesthesiologist, surgeon, operation assistants etcetera). And that these people take care of you, by for example giving you important information to perform your tasks safely (Duda & Appleton, 2016). Additionally, the relatedness to the monitoring task one is performing is important. As the monitoring task is performed mostly individually by the anesthesia assistant, and the monitoring devices help the anesthesia assistant in their task as well as there is an indirect relatedness with the patient that is monitored. *Competence* stands for the anesthesia assistants to feel that they have the competencies to be able to meet the demands and responsibilities of their monitoring task (Duda & Appleton, 2016).

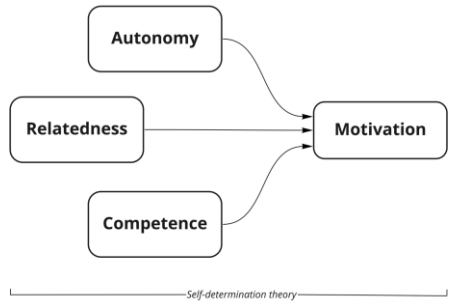


Figure 3. Self-determination theory: autonomy, relatedness, and competence impact motivation (Own visualisation, interpretation based on the Self-determination theory by Deci & Ryan (1985) (Deci & Ryan; 1985)).

2.3.2. Self-efficacy theory

In the *Self-efficacy theory*, it is stated that psychological actions can strengthen someone's self-efficacy, defined as the perception or belief of a person in their own capabilities to perform actions at the desired level. Four psychological actions are distinguished to impact self-efficacy: *verbal persuasion*, *performance accomplishment*, *vicarious experiences*, and *psychological arousal*, see Figure 4 (Bandura, 1977). Multiple studies as by Stajokovic & Luthans (1998) and Multon, Brown & Lent (1991) have shown that self-efficacy has a powerful impact on motivation, according to Schunk & Pajares (2009) (Schunk & Pajares, 2009; Stajkovic & Luthans, 1998; Multon, Brown & Lent, 1991).

Self-efficacy is gained throughout the performance of tasks, in which someone receives information about how well their performance is, which affects their subsequent learning and performing (Schunk, 1995). The perception of a person on their own capabilities are key determinants to successful results (Gallagher, 2012).

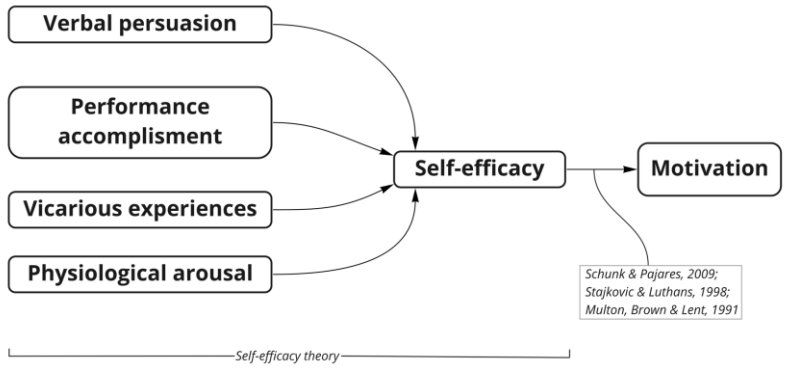


Figure 4. Self-efficacy theory and the impact of self-efficacy on motivation. (Own visualisation, interpretation based on the Self-efficacy theory by Bandura (1977) and the relation between self-efficacy and motivation according to Schunk & Pajares (2009), Stajokovic & Luthans (1998) and Multon, Brown & Lent (1991) (Bandura, 1977; Schunk & Pajares, 2009; Stajkovic & Luthans, 1998; Multon, Brown & Lent, 1991)).

Self-efficacy in this context refers to the perception, or their own judgement and confidence, of the anesthesia assistant that their own capabilities are on such level that they are able to perform the monitoring task successfully. The four psychological actions of verbal persuasion, performance accomplishment, vicarious experiences, and physiological arousal, are said to impact the self-efficacy. As there is no clear definition of these four psychological actions in the Self-efficacy theory, the interpretation of these is made based on the definitions defined by Hoffart (2002) (Hoffart, 2002). Verbal persuasion, performance accomplishment, vicarious experiences, and physiological arousal can then respectively be explained in this context as the encouragement by colleagues and receiving their positive feedback, performing the monitoring task successfully while solving potential issues, observing a colleague cope with the task, and being in a state of high alertness, with heightened blood pressure and heartbeat.

2.3.3. Expectancy-value theory

The *Expectancy-value theory* is described differently by various researchers, as well as extended in various ways by other researchers. For this study, the explanation by Studer & Knecht (2016) of the Expectancy-value theory, as described by Vroom (1964) and extended by Lawler and Porter (1967), is used (Vroom, 1964; Studer & Knecht, 2016). According to Studer & Knecht, the Expectancy-value theory as described by Vroom (1964), also referred to as Vrooms Expectancy theory, states that the factors of expectancy and value determine the motivation of someone to perform a certain action or behaviour (Vroom, 1964; Studer & Knecht, 2016). This explanation was chosen for the Expectancy-value theory as it matched with the context of anesthesia assistants performing their task of patient monitoring.

Expectancy is described as the perceived effort-performance probability. The expectancy factor can be divided into two components, according to Vroom (1964). Firstly, the belief of a person that there is a probabilistic association between their action and the desired outcome. And secondly, the belief of a person in their ability to perform the monitoring task successfully, at the needed level (Vroom, 1964; Studer & Knecht, 2016). According to Lawler and Porter (1967), that extended the theory by Vroom, value can be defined as the degree to which an outcome of an action in a task is thought to meet requirements for security, esteem, autonomy, and self-actualisation (Studer & Knecht, 2016; Lawler & Porter, 1967).

In the context of anesthesia assistants' motivation for their monitoring task, the factors of expectancy and value would this way impact the motivation of anesthesia assistants for the behaviour of performing their task of patient monitoring as well as for the actions within the monitoring task.

Expectancy in this context stands for how probable an anesthesia assistant finds it that the desired outcome will be reached through their action. The two components that influence this expectancy, and thus the anesthesia assistants' motivation for their monitoring task, would then be the belief of the anesthesia assistant that there is a probabilistic association between action and desired outcome, and the belief of the anesthesia assistant in their ability to perform the monitoring task successfully at the needed level. However, the belief in the probabilistic association between action and desired outcome is less connected to the personal motivation of an anesthesia assistant and depends on the situation, as the type of surgery, the patient, or the surgeon at duty. This probabilistic association between action and desired outcome is not always easy to determine for the anesthesia assistant because of the complexity of the situation. Furthermore, it is difficult to make this variable measurable, and it might therefore have a confusing effect if incorporated in the motivational theory model to determine motivation among anesthesia assistants. That is why this factor is determined to be not included in the motivational theory model as motivational factor for anesthesia assistants' motivation in the monitoring task, as visualised in Figure 6. The belief of the anesthesia assistant in their ability to perform the task successfully matches the earlier mentioned self-efficacy and is therefore further defined as self-efficacy.

Value stands for how much the anesthesia assistant values the outcome that will be reached through their actions. If an outcome of the monitoring task is regarded to meet requirements for security, esteem, autonomy, and self-actualisation, value will be a positive factor contributing to the motivation of the anesthesia assistant. As security, esteem, autonomy, and self-actualisation are not defined by Lawler & Porter (1967) or Studer & Knecht (2016), the definitions were based on interpretation. Security in this context may be defined as the feeling of security an anesthesia assistant gets from performing the monitoring task actions. This feeling of security is mostly dependent on the working conditions one must work in, and the guidance that one gets from the anesthesiologist and management. Esteem can be seen as self-esteem. So, how the anesthesia assistants see themselves and how they feel about their abilities and limitations as result of the tasks they perform. Esteem can be divided into two elements: the feeling of self-confidence, and the feeling that your abilities and contributions are approved and appreciated by others (McLeod, 2007). Situational characteristics like expectations and/or appreciation by others affect your self-esteem (Demo, 1985). To be able to define your feeling about your abilities, one mirrors them to the outside world by comparing your abilities and limitations to other people to be able to quantify them. Autonomy means that as result of performing the monitoring task successfully, anesthesia assistants gain more autonomy as the anesthesiologist is giving them responsibility to perform more actions individually, without supervision. Self-actualisation means the developing and fulfilling of anesthesia assistants' talents and potential (McLeod, 2007). This can amongst others be reached by learning new things and learning from others.

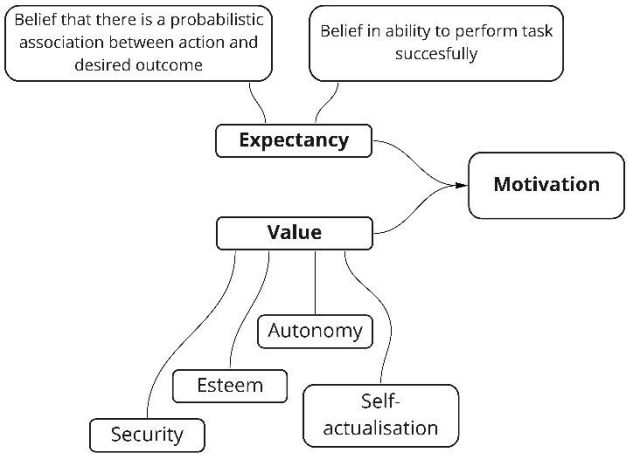


Figure 5. Expectancy-value theory and the impact on motivation. (Own visualisation, interpretation based on the Expectancy-value theory by Vroom (1964) and extended by Lawler and Porter (1967), as described by Studer & Knecht (2016) (Vroom, 1964; Lawler & Porter, 1967; Studer & Knecht, 2016)).

The motivation to perform a certain action or behaviour in this theory is described to be determined by the expectancy and value. By not including the probabilistic association, the expectancy is decided to only consist

of the self-efficacy factor. The value factor that impacts motivation is determined by the degree of security, esteem, autonomy, and self-actualisation as result of performing the action or behaviour. As the anesthesia assistant continuously performs the actions in the patient monitoring task during the operation, it is assumed in this study that security, esteem, autonomy, and self-actualisation are factors that impact the motivation of anesthesia assistants to perform their task of patient monitoring, see Figure 5.

The factors of autonomy and self-actualisation are related to the task, and to the person performing the task. However, esteem and security on the other hand, are less related to the task specifically or the person themselves performing the task, and more to the outside world, and are therefore decided to not be included in the motivational theory model as visualised in Figure 6.

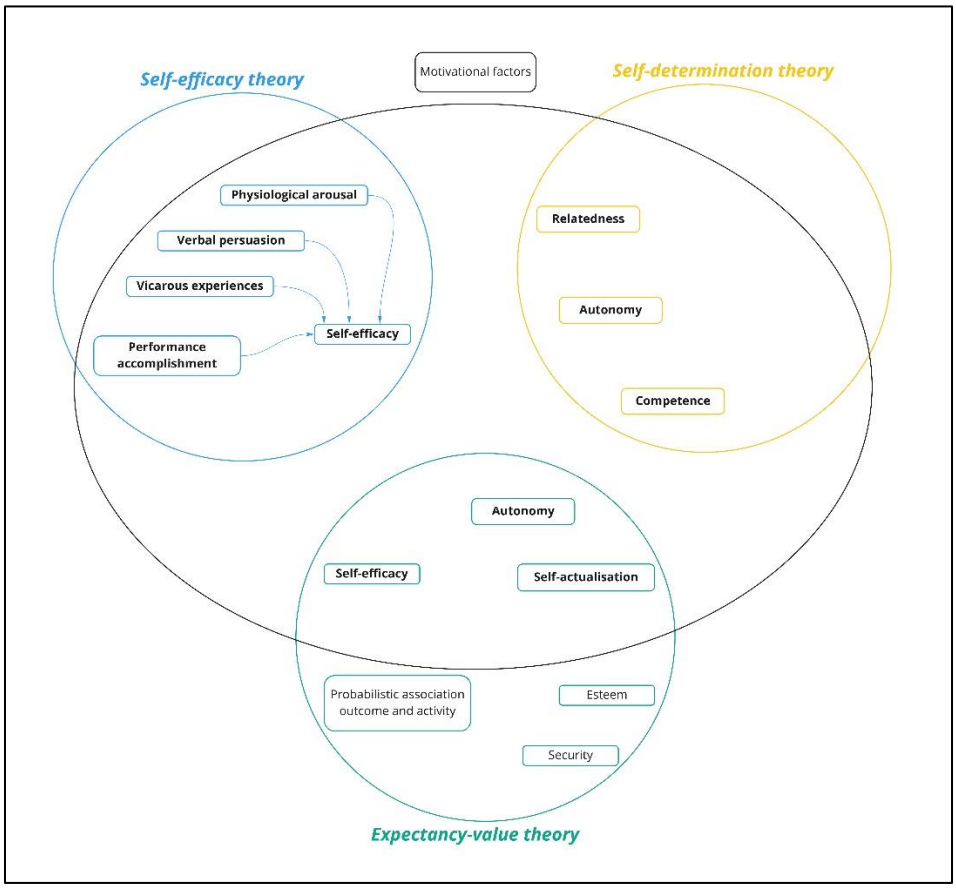


Figure 6. Motivational theory model for the motivation of anesthesia assistants in their patient monitoring task. (Own visualisation, interpretation based on the Self-efficacy theory by Bandura (1977), the Self-determination theory by Deci & Ryan (1985), and the Expectancy-value theory by Vroom (1964) and extended by Lawler and Porter (1967), as described by Studer & Knecht (2016) (Bandura, 1977; Deci & Ryan, 1985; Deci & Ryan 2015; Vroom, 1964; Lawler & Porter, 1967; Studer & Knecht, 2016)). The motivational factors of the Self-efficacy theory, Self-determination theory, and Expectancy-value theory that are included in this motivational theory model are visible within the black circle. The four psychological actions of verbal persuasion, performance accomplishment, vicarious experiences, and psychological arousal, that are found to impact self-efficacy, are not motivational factors in themselves. However, these actions are included in the model, as the expected impact of these actions on the self-efficacy of anesthesia assistants is considered noteworthy and therefore specifically researched in this study. The on theory-based definitions of all factors and the actions can be found in Sections 2.3.1, 2.3.2, and 2.3.3.

2.3.4. Overlap and links between the motivational theories: motivational theory model

There are some overlaps between the three different theories, in the form of matching factors and factors that have mutual links, as drawn in Figure 7. Firstly, the belief of the anesthesia assistant in their ability to perform the task successfully was found to match with the self-efficacy definition of the Self-efficacy theory, meaning that there is an overlap between the Self-efficacy theory of Bandura and the Expectancy-value theory of Vroom. Secondly, the factor of autonomy of the Expectancy-value theory overlaps with the autonomy factor of the Self-determination theory. Thirdly, competence in health care personnel is deemed essential for self-actualisation (Shahrbabaki, Rafati & Sarabi, 2020). The factor of competence of the Self-determination theory by Deci and Ryan is this way related with the self-actualisation factor of the Expectancy-value theory. Fourthly,

self-efficacy is defined as the perception of the anesthesia assistant that their own capabilities are good enough to be able to perform the monitoring task successfully, meaning that one needs competencies to be able to have self-efficacy (Fernet et al., 2008). This highlights the link between the factor of self-efficacy of both the Self-efficacy theory and the Expectancy-value theory with the Self-determination theory.

Finally, the four actions of verbal persuasion, performance accomplishment, vicarious experiences, and physiological arousal, that are said to impact self-efficacy, also have links with factors of the other motivational theories. For performance accomplishment to have impact on self-efficacy, one needs autonomy and competence to be able to fulfil a task. Likewise, for verbal persuasion by colleagues to impact the self-efficacy of an anesthesia assistant, there needs to be relatedness with colleagues.

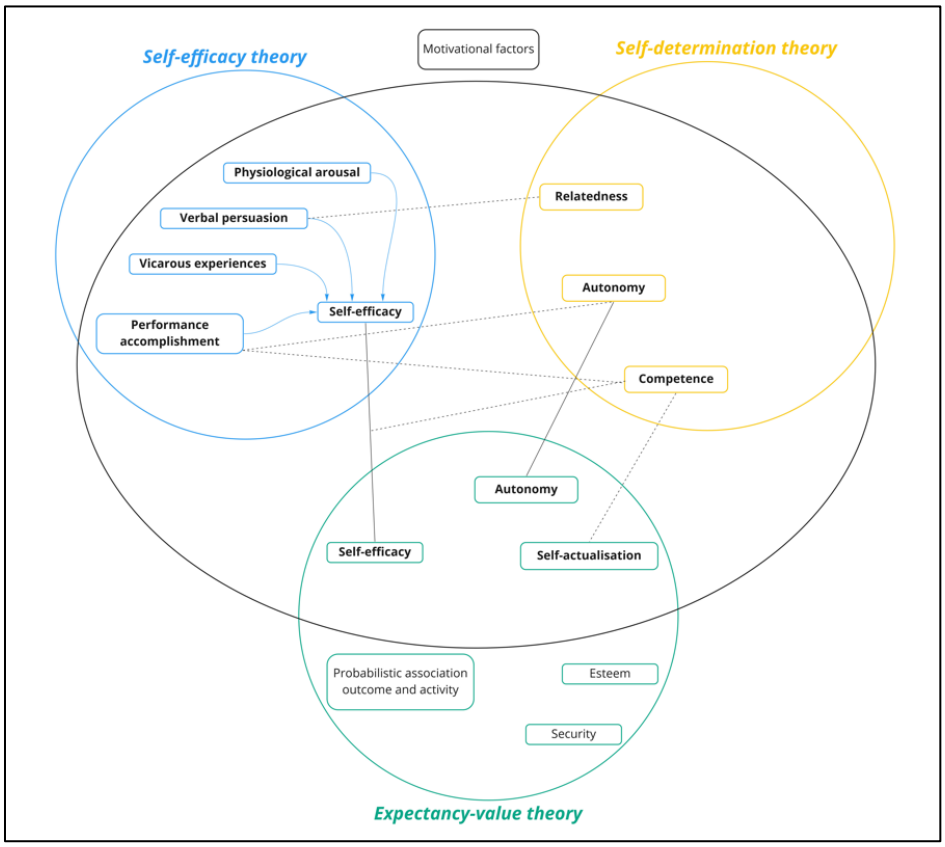


Figure 7. Motivational theory model for the motivation of anesthesia assistants in their monitoring task, with links between the factors in the different theories. (Own visualisation, interpretation based on the Self-efficacy theory by Bandura (1977), the Self-determination theory by Deci & Ryan (1985), and the Expectancy-value theory by Vroom (1964) and extended by Lawler and Porter (1967), as described by Studer & Knecht (2016) (Bandura, 1977; Deci & Ryan, 1985; Deci & Ryan 2015; Vroom, 1964; Lawler & Porter, 1967; Studer & Knecht, 2016)). The blue lines from the four actions of verbal persuasion, performance accomplishment, vicarious experiences, and physiological arousal, are impacting self-efficacy. The black lines indicate matching factors (thick line) or factors that have mutual links (dotted line). The on theory-based definitions of all factors and the actions can be found in Sections 2.3.1, 2.3.2, and 2.3.3 (Bandura, 1977; Deci & Ryan, 2015; Vroom, 1964; Studer & Knecht, 2016; Lawler & Porter, 1967). The explanation of the links between the factors can be found in Section 2.3.4 (Shahrbabaki, Rafati & Sarabi, 2020; Fernet et al., 2008).

2.4. Learning about AI-assisted monitoring

Vocational education and developing towards a deliberate professional

The education of anesthesia assistants is a form of vocational education, where people are trained towards the development of competences regarding the specific professionals they become (Harrison, 1994). In educating professional practitioners, there is an increasing attention for the reflective and deliberate professional. Schön (1987) describes the need to improve the ability of practitioners to perform 'reflection-in-action' through their education. These professionals do not only use scientific knowledge, but also implicit, intuitive knowledge learned through improvisation in professional practice. By reflecting on their practice-based knowledge during their actions, advancement in their knowledge as well as their personal development can take place. This enhances their ability to solve problems and enables them to cope with unique, complex, and uncertain

problems encountered in practice (Schön, 1987; Schön, 2017; Loftus et al., 2013). The deliberate professional is an extension of the reflective professional. Meaning that people are encouraged to make conscious decisions about their acting and behaving in practice, and with that may become professionals that are amongst others more morally responsible and reflective on themselves (Trede, McEwen & Ryan, 2021; Trede & Jackson, 2021). According to Trede, McEwen & Ryan (2021), multiple elements are important in the development towards a deliberate professional. Amongst others, learning to carefully consider the complexity of the practice as well as the working environment and culture, learning to deliberately position oneself in practice and in decision-making, and gaining awareness and responsibility on the consequences of their actions as well as the consequences of not performing certain actions (Trede, McEwen & Ryan, 2021; Trede & McEwen, 2016). Anesthesia assistants are working in a complex, continuously changing practice and working environment, in which their decisions and actions are directly related to the safety of the patient as well as the functioning of other professionals such as the surgeon (see Chapter 4). Anesthesia assistants are thus continuously required to make the right decisions, as well as substantiate those decisions. Hence, guiding them towards becoming deliberate professionals is essential. Moreover, the professional behaviour of health care professionals is influenced by their motivation (Buetow, 2007). Insight in their own motivation is thus an important factor to incorporate in the development of anesthesia assistants towards deliberate professionals.

Scaffolding-approach

An educational module to enable users to learn about AI-assisted monitoring and motivation can be build up in various ways. By breaking-up the learning process into smaller parts, see Figure 8, a learner is allowed to learn and practice with lower pressure (Carberry, Johnson & Henderson, 2015). In the scaffolding-approach, originating from pedagogic theories, the major learning objective that one must complete is carefully divided into sequenced sub-parts based on the learner's level (Wilson & Devereux, 2014). This provides a supporting structure that allows a learner, that might have difficulties in reaching a final goal, to step by step get to the next stage in reaching the final goal.

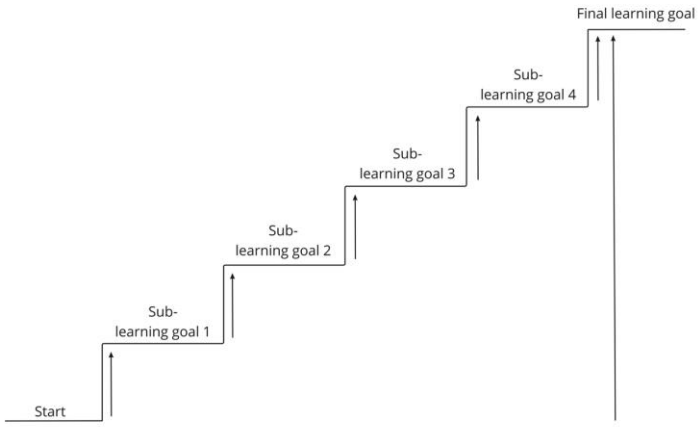


Figure 8. Scaffolding-approach in a learning process. (Own visualisation, adapted from (Carberry, Johnson & Henderson, 2015)). The major learning objective that a learner must complete is divided into sequenced sub-parts with sub-learning goals, to enable a learner to step by step reach the final goal.

Taxonomy of Bloom

To further decide on how an educational module is build-up, a taxonomy is used. Taxonomies are frameworks, that are used in education to structure learning units and goals. The taxonomy of Bloom is an often-used taxonomy to set-up different proficiency levels of knowledge (Karels, 2020). The educational programme of anesthesia assistants in the Leiden University Medical Center (LUMC) hospital also uses this taxonomy to set-up educational modules (F. Janszen, educator of anesthesia assistants, personal communications, April 22, 2022). As this educational module is set-up using the scaffolding approach, a taxonomy in which a distinction is made in different levels of knowledge and the associated learning goals suits perfectly.

The taxonomy of Bloom comprises a pyramid with different categories that build up in difficulty and complexity, meaning that the skill or ability in a lower section of the pyramid must be reached first before a skill or ability in a higher section can be achieved. In the Revised Taxonomy of Bloom by Anderson and Krathwohl, as visible in Figure 9, six different levels can be distinguished, with the lowest three levels comprising lower-order thinking skills and the highest three levels comprising higher-order thinking skills (Wilson, 2016). The basis of the pyramid contains 'remembering', meaning that a learner must be able to

recognise and recall facts and information previously learned about the subject (Wilson, 2016). In the second level of the pyramid, 'understanding' is central, thus the construction of meaning from the texts, images, or activities in the educational module by the learner. The third level focuses on 'applying', where the previously learned information must be used or implemented in a new situation by the learner. In the subsequent level of 'analysing', the learner must break down the learning material into parts to determine the relationships between the different parts and the relation to an overall goal or structure. In the fifth level of 'evaluating', the learner may examine and check the information, and make judgements. The highest level of this pyramid focuses on 'creating', where the learner can use the learned information to generate or produce something new, by putting elements together or reorganise elements and create a coherent or functional whole (Wilson, 2016; University of Florida, n.d.).

This revised taxonomy focuses on teaching both the knowledge and the cognitive process levels (Wilson, 2016). As a result, learners can receive factual knowledge, but also are able to apply what they have learned right away as well as ask questions to themselves to analyse and evaluate on the topic.

Furthermore, in contrast to the original version, in this revised taxonomy the evaluation level is placed lower than the creation, or synthesis, level, because one needs to evaluate before one is able to create something new (Wilson, 2016). This taxonomy may help to formulate learning goals of different sub-modules in an educational module. And to decide what the learner must be able to know or do at the end of a sub-module and which assignments the sub-modules must contain to enable users to reach that (Karels, 2020). In Table E.1 in Appendix E, an overview of words that correspond with the different thinking skills orders that can be used to formulate the learning goals, is shown.

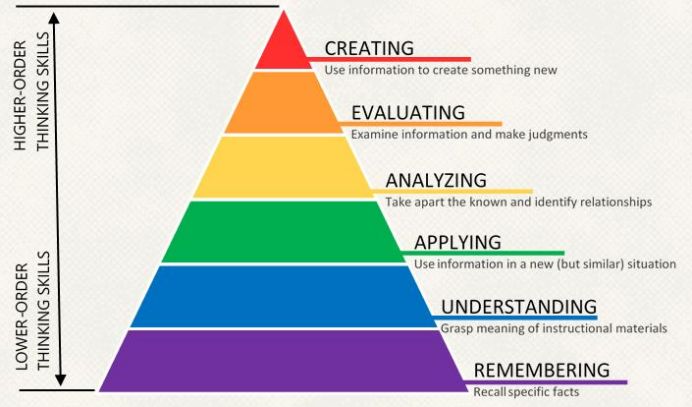


Figure 9. Revised Taxonomy of Bloom (University of Florida, n.d.). Comprising six different levels of thinking skills that build up in difficulty and complexity. The lowest three levels comprise lower-order thinking skills and the highest three levels comprise higher-order thinking skills (Wilson, 2016).

Cooperative learning and motivation

Furthermore, as anesthesia assistants work in a very practical environment of the OR, but also in interaction with their social environment of anesthesia assistant colleagues and anesthesiologists, the theories of social learning are explored. The idea that learning occurs in social settings through interactions with colleagues and those that are more knowledgeable on the topic of interest, is the basis of the social learning theories by Vygotsky (Wilson & Devereux, 2014; Vygotsky & Cole, 1978). According to Vygotsky's theory, every learning person has a higher learning ability if one interacts with peers and receives support (Wilson & Devereux, 2014). This can also be used in groups, making learners to work and learn together in shared activities, enabling peers to learn from each other, and potentially a teacher or expert can guide the learning process (Gauvain, 2020). Learning in groups increases the positive interdependence, meaning that cooperative learning takes place (Johnson & Johnson, 2002). As this encourages learners to participate actively in the learning process, this also increases their motivation (Abass, 2008). The Self-determination theory distinguishes extrinsic and intrinsic motivation (see Section 2.3.1). Intrinsic motivation causes high-quality learning and creativity in the learner (Ryan & Deci, 2000c). However, the intrinsic motivation to learning cannot always be reached in every student. That is why the educational module must both address components of intrinsic motivation and extrinsic motivation in learners, to motivate them to participate in the educational module as well as increase the effectiveness of the module.

3. Methodology

3.1. Overall approach

There is currently a lack of knowledge about the attitude of anesthesia assistants towards AI-assisted monitoring, the factors that influence their motivation in monitoring and the possible effect of the use of AI on these factors. This *explorative* and *qualitative* study provides insight in these topics, as well as it aims to contribute to the knowledge of anesthesia assistants on AI-assisted monitoring and their motivation in the future by means of an educational module. Explorative research comprises the exploration, or investigation, of a topic that is relatively new as well as not clearly defined. It results in an improved insight and a better understanding of the problem, but will not yield conclusive results (Babbie, 2016). Qualitative research uses open-ended conversational research methods to gather descriptive information directly in the natural field, as compared to quantitative research where for instance questionnaires are used to obtain numerical, measurable data. Qualitative research allows for the exploration of a topic through for instance interviews, in order to gain more details on the why and how (Babbie, 2016). Explorative research is the preferred option for this study, as there is little knowledge on the topics beforehand, and it allows to adapt the research direction in response to the findings during the research. Qualitative research allows to clearly explain the complex topic of AI-assisted monitoring to anesthesia assistants, as well as the topic of motivational factors, and prevent misunderstanding. Furthermore, it allows to delve deeper into their attitude and motivation, which is very valuable for this explorative research.

To be able to answer the five sub-questions and with that the central research question of '"How can knowledge on the attitude of anesthesia assistants towards Artificial Intelligence (AI) and their motivation in their task of patient monitoring in the Operating Room (OR) be used to build an educational module that could support anesthesia assistants in their awareness and understanding of the impact of AI-assisted monitoring?", both literature research and semi-structured interviews were performed. This study focuses on the OR-environment in the LUMC hospital, which is an academic hospital in which research and new developments play a central role.

Design-based research is used as research approach, which comprises a methodology in which research and design are integrated, aiming to increase the impact of research on improving practice (Reimann, 2011; Anderson & Shattuck, 2012). According to Reimann (2011), "Design-based research, with the design experiment as its main practical method, can be characterised as an inter-disciplinary 'mixed-method' research approach conducted 'in the field' that serves applied as well as theory-building purposes." (Reimann, 2011). 'In the field' means in this case the anesthesia assistants in their working environment of the OR. Design thinking is applied in this study by starting with the identification of the problem, after which a solution to the problem is designed through an iterative process. Furthermore, theory and practice are linked continuously in design thinking, avoiding the direct 'problem-to-solution thinking'. This results in intertwined theory development and theory testing (Reimann, 2011; Cross, 2004; van der Sanden & Vries, 2016; Scott, Wenderoth & Doherty, 2020). Following the double diamond model by the British Design Council is a means to operationalise design-based research (see Figure 10) (Design Council, 2022). This double diamond model starts with a phase, or a diamond, to understand and define the context and problem, and ends with a phase in which a solution for the problem is created. Design-based research fits this study as the final goal is to include the gained knowledge into the development of an educational module that will improve the educational practice and support anesthesia assistants. The insights that are gained in this study form the basis for the content of an educational module.

Prior to conducting the research that leads to the answer on the research question, explorative interviews are held and literature research is performed to discover both the fields of AI development and medical support staff at the OR, to be able to determine the direction of the research. Subsequently, literature research and semi-structured interviews with anesthesia assistants and an anesthesiologist are performed, two operations are attended during a visit to the OR center of the LUMC, and conversations with people that work in the AI-healthcare field are held. In this way, the tasks and responsibilities of anesthesia assistants are explored and the possibilities in AI-assisted monitoring are defined. Also, the attitude of anesthesia assistants on AI-assisted monitoring, their motivation in monitoring, and the possible effect of AI-assisted monitoring on the motivational factors important to anesthesia assistants are investigated.

Finally, a solution is created with the information gained in the first part of the research, in the form of a first draft of an educational module. Investigation of how an educational module would best fit the anesthesia assistants' learning as well as iterative co-design sessions are needed to develop such an

educational module that connects to the knowledge, interest, and way of learning of anesthesia assistants to give them best support for the future use of AI in their monitoring task. Additional questioning of anesthesia assistants about their interest and needs for an educational module about AI and motivation delivered the design requirements for such educational module. Through co-design sessions with fellow students, a graduate, and professor, a final draft could be made and discussed with an anesthesia educator as form of expert validation. This educational module can support anesthesia assistants by increasing their awareness and understanding of the impact of the use of AI-assisted monitoring in their monitoring task.

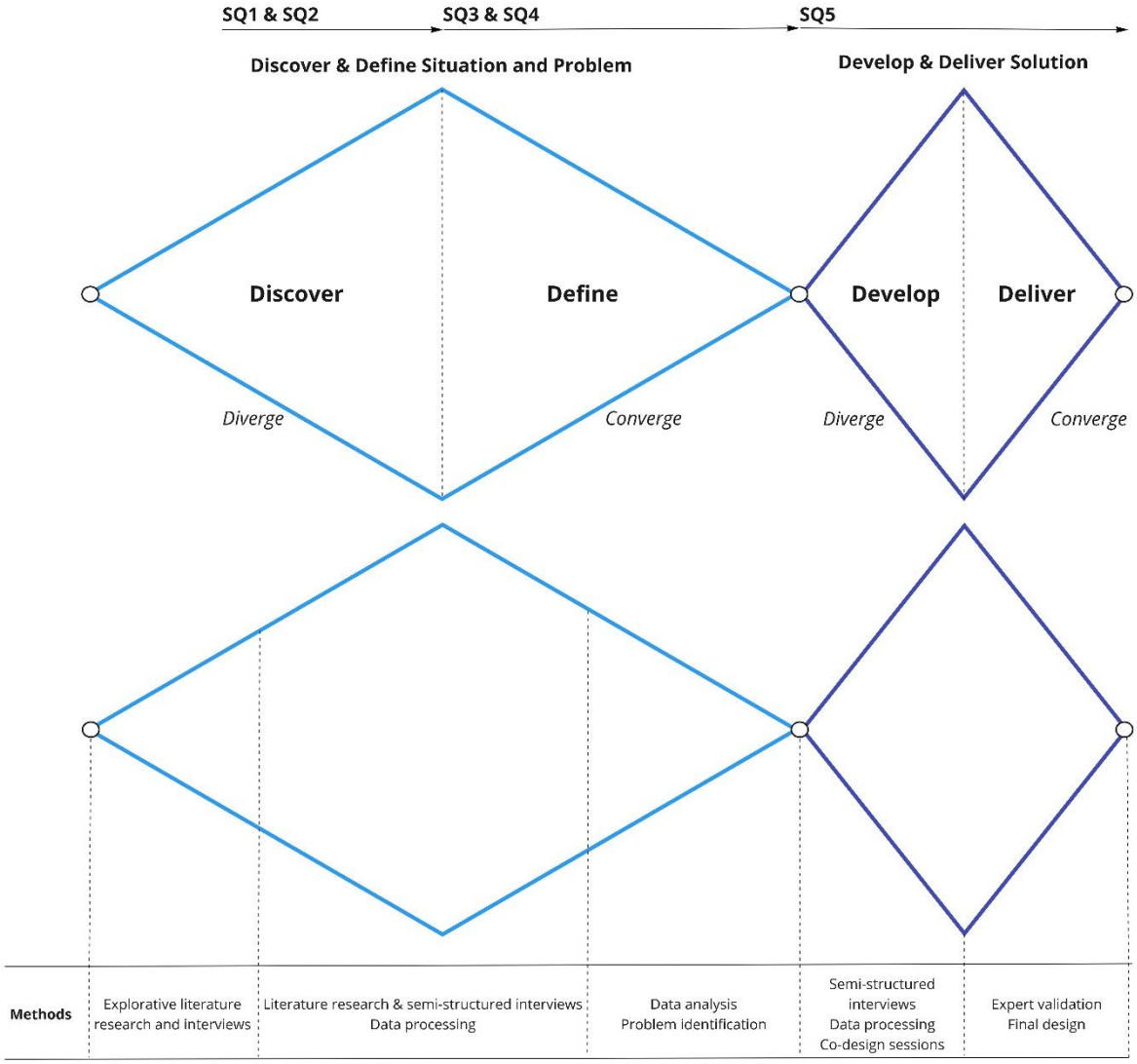


Figure 10. Double diamond model (Own visualisation, adapted from Design Council (2022)). The double diamond model comprises two diamonds, in which first divergent thinking takes place, meaning that information is searched and explored, after which convergent thinking takes place, where the information is focused to define a clear problem in the first diamond, or clear result in the second diamond. The first diamond is larger than the second diamond as, time-wise concerned, the first diamond included a larger part of the research. The methods that are used in the different parts of the double diamond model in this study are named below the diamonds. Explorative literature research and interviews were performed to discover the field of AI at the OR and what a good focus point could be. Subsequently, literature research on attitude and motivation, the profession of anesthesia assistants, and the possibilities in AI-assisted monitoring was done, combined with semi-structured interviews with anesthesia assistants to investigate their perception and attitude towards AI-assisted monitoring. This data was processed and analysed, to identify the problem that could lead to the development of a solution on how to support anesthesia assistants. Through the semi-structured interviews with anesthesia assistants, the design requirements for the educational module were explored. Data processing and co-design sessions with fellow students, a graduate, and professor of the TU Delft, led to the development of a draft version of an educational module. Through expert validation of this draft module, a final design for the educational module was made, that could serve as a solution in the supporting of anesthesia assistants in their awareness and understanding of the impact of the use of AI-assisted monitoring in their monitoring task.

3.2. Operationalisation

Each of the subjects central in this research (described in Chapter 2), are operationalised into measurable indicators, see Table A.1 in Appendix A. The measurable indicators are subsequently used in the interview questions for the semi-structured interviews with anesthesia assistants and data analysis of the interviews, see Section 3.5.2 and Section 3.5.3 and Appendix B. Important to note is that measurement in this case is not quantitative but qualitative.

Firstly, perception of AI at the OR by the anesthesia assistants, is measured using the indicators of the knowledge of anesthesia assistants on the possibilities of AI at the OR, their interest in its use, and their expectations (see Table A.1). Secondly, behavioural intention to use AI-assisted monitoring, can be divided into multiple related variables, namely the attitude towards behaviour of using AI, the perceived usefulness, the perceived ease of use, and subjective norm. All these related variables were measured using the assigned indicators, see Table A.1.

Thirdly, the task-related motivation is also divided into six related variables. Namely, the self-identified motivational factors of anesthesia assistants and the various motivational factors identified in literature of autonomy, relatedness, competence, self-efficacy and self-actualisation. The measurement of the motivational factors from literature was performed using a Likert scale of unimportant to very important, as well as a mutual comparison in importance among the factors. Furthermore, the identification of mutual relations between the factors was used as indicator. For the variable of self-efficacy, it was also measured what effect verbal persuasion, performance accomplishment, vicarious experiences, and physiological arousal have on the self-efficacy. Finally, also the impact of AI-assisted monitoring on motivation is measured using the assigned indicators in Table A.1.

3.3. Literature research

Literature research is performed to discover the tasks, responsibilities, and working environment of anesthesia assistants, as well as the contemporary developments in AI for anesthesia at the OR and the possibilities of AI in monitoring and prediction of risk factors. Furthermore, literature research is performed to establish the theoretical framework, comprising the subjects of attitude and motivation, and the structure of the educational module. Literature searches were performed through search engines, as described below. Additionally, articles around these subjects were obtained via experts, as well as the snowball effect was used, meaning that additional articles were found through the references of the previously found and obtained articles.

For the chapter regarding the tasks and working environment of anesthesia assistants (Chapter 4), mostly the search engine PubMed was used to find articles because this search engine focuses mainly on literature of medicine and life sciences. Sometimes also the search engine of Google Scholar was used to find additional articles if searches through PubMed did not result in the desired outcomes. Articles were found this way by using key word search terms such as operating room, operating theater, healthcare, surgery, operation, anesthesia, nurse, assistants, team, job, task(s), monitoring, education, and complexity.

For the chapter about the possibilities in AI-assisted monitoring (Chapter 5), the main search engine of Scopus was used, which is a search engine that is accepted and used by many universities (Harzing & Alakangas, 2016). This was supplemented with a smaller number of searches via the search engine of Google Scholar. For these searches, key word search terms such as artificial intelligence, machines, algorithm, model, machine learning, predicting/prediction, events, monitor/monitoring, technology, anesthesia, healthcare, operating room, implementation, application, vital parameters, BIS monitor, automation, and reinforcement learning were used.

For the subjects of anesthesia assistants and their working environment, and the AI possibilities, the date of publishing range of 2010 to present was used. This, to ensure findings to match with the contemporary profession, as well as to make sure the newest developments in the field of AI for healthcare would be found. However, also some articles were found through the snowball effect, resulting in articles before 2010.

The literature research for the building of the theoretical framework was performed by using the search engines of Scopus and Google Scholar. Scopus has a wide coverage of scientific journals, but Google Scholar provides three to four times the number of papers in the field of Social Sciences than Scopus (Harzing & Alakangas, 2016). Articles were found by using key word search terms such as user, perception, attitude, acceptance, adoption, use, theory, model, healthcare, anesthesia, behaviour, prediction, artificial intelligence, technology, theory of reasoned action, perceived usefulness, perceived ease of use, subjective norm,

motivation, motivational factors, self-determination theory, Maslow's hierarchy of needs, equity theory, self-efficacy, expectancy-value, self-actualisation, autonomy, education, practice, scaffolding, taxonomy, healthcare, anesthesia, nurse, assistants, tasks, job, artificial intelligence, monitoring, motivation, acceptance, attitude, adoption, technology, education, scaffolding, taxonomy, Bloom, revised, learning, goals, cooperative, vocational, reflective, deliberate, and professional. For the theoretical framework, there was no limitation used in the date of publishing range.

In all searches, criteria for the selection of articles were used. The first selection method was top of the list and the match of the document title with the subject. Subsequently, the number of citations of the article was checked. Also, the journal and the year of publication were checked to determine the potential match of the journal with the subject and the contemporariness of the article. All searches were included into a logbook. The abstract of an article was read, after which the article was included or discarded. Then, the introduction and conclusion of the included articles were read, and the rest of the document was scanned or fully read. All included articles as well as important pieces of text from the articles were included into a logbook.

3.4. Explorative interviews

Multiple explorative interviews, or conversations, were held to investigate the field of AI in healthcare, as well as the field of medical support staff in the OR. For the research in the field of AI, different persons were interviewed. Firstly, Hidde Jessen, who has a Master of Science in AI, and performed research on the cardiology department of the University Medical Center Utrecht to recognise diseases based on electrocardiography. Secondly and thirdly, Rick Butler and Teddy Vijfvinkel, both PhD students at the TU Delft performing research on the application of AI techniques in ORs to optimise workflow efficiency. Butler has a MSc in Electrical Engineering and Vijfvinkel has a MSc in Medicine. These three persons were interviewed because they were easily approachable through short communication lines. Furthermore, Hidde Jessen could provide an overview on the topic of AI in general as well as specifically in healthcare, and Rick Butler and Teddy Vijfvinkel could specifically provide insight in AI at the OR. Additionally, Teddy Vijfvinkel has expertise on collaboration with medical professionals regarding AI development. Fourthly, a conversation with Feline Spijkerboer was held, who is a data scientist in the LUMC and works on a project on the use of AI in postoperative care at the LUMC. She was approached as it provided an opportunity to learn about AI research and development at the LUMC itself. Fifthly, a conversation was held with André Krom, a researcher at the LUMC on guidance ethics for technology in healthcare. Feline Spijkerboer recommended the contact with André Krom as guidance ethics could be a possible interesting direction for this research. All the information gathered in these interviews and conversations, was used to determine the focus of the research as well as to write parts of Chapter 5 and Chapter 10.

For the exploration of the field of medical support staff in the OR, an explorative interview was held with a teacher in the care sector at the LUMC, who could be contacted directly through an acquaintance. Furthermore, two interviews were performed with an anesthesia assistant at the LUMC and an anesthesiologist outside of the LUMC. These two persons were also contacted through an acquaintance, and allowed to explore the focus on anesthesia care within the OR. These two interviews were partly transcribed and partly summarised. The relevant parts of the interviews were coded and analysed in correspondence with the semi-structured interviews, see Section 3.5, and used in Chapter 4, Chapter 6, and Chapter 7, where this anesthesia assistant and anesthesiologist are respectively mentioned as AM0 and AL1. An interview with an anesthesia educator of the LUMC, Frank Janszen, was held as expert validation for the educational module, see Chapter 8. Finally, conversations with another anesthesiologist and anesthesia assistant, both working at the LUMC, were held to verify some information of Chapter 4.

3.5. Semi-structured interviews

For the investigation of the perception, attitude, motivation, and impact of AI on motivation, semi-structured interviews with anesthesia assistants were performed. Also, the tasks and responsibilities of anesthesia assistants, and their interest and needs for an educational module, were investigated in these semi-structured interviews.

Semi-structured interviews were chosen, as it allows to gain open-ended answers on the different topics, as well as to bring structure in the answers of the interviewees so that comparison of the answers is possible. Furthermore, it allows to delve deeper into the, sometimes difficult and sensitive, topics in

comparison with for example a survey. Also, misunderstanding can be prevented by detecting incomprehension or unclarities after which explanation of the questions or topics is possible.

3.5.1. Selection of participants

The anesthesia assistants for the semi-structured interviews were collected via a snowball effect. Firstly, a befriended employee at the LUMC hospital helped to connect with an anesthesia educator at the LUMC, and with that a contact of a team leader of anesthesia assistants at the LUMC. That team leader sent out three times a request to participate in interviews embedded in the weekly newsletter of the anesthesia assistants. There were no criteria for the selection of the interviewees other than that they had to be working as anesthesia assistant at the LUMC hospital. This way, a diverse group of anesthesia assistants was gained, comprising five male and three female anesthesia assistants with varying age and experience. This group of anesthesia assistants thus included both younger and older anesthesia assistants, meaning that some also have worked in a time that values of the monitoring had to be written down by hand. As the selection of participants went via email, and participation was completely voluntary, only anesthesia assistants that were willing to be interviewed were included in this study.

3.5.2. Construction and execution of the semi-structured interviews

The semi-structured interviews focused first on the subject of the tasks, responsibilities, and working environment of the anesthesia assistants. Subsequently, the interview questions were constructed based on the indicators of the operationalisation. This way, the perception of the anesthesia assistants towards AI in the OR, the attitude towards AI-assisted monitoring, and the motivation of anesthesia assistants for their monitoring task was investigated. The attitude investigation also comprised their perceived ease of use and perceived usefulness of AI-assisted monitoring, their subjective norm, and preferences and concerns about using AI-assisted monitoring. Investigation of the motivation included an open question on what is important for their motivation, which of the theoretical motivational factors of the motivational theory model are important to their motivation in monitoring and in which ranking, which relations they see between the motivational factors, and what impact they think AI might have on these motivational factors. Finally, also questions about their design requirements for an educational module were asked.

The answers of interviews provided input for subsequent interviews, both in how to formulate certain questions in a way that it was clear to the anesthesia assistant, as well as that the focus of the interviews slightly changed and new questions came up. Hence, there are multiple interview protocols (see Appendix B). This gives the advantage of being able to use earlier input to sharpen the research questions, therewith creating more focus in the research, but also the disadvantage of less generalisability of the answers due to different questioning.

Eight interviews with anesthesia assistants of the LUMC were executed in a private setting at the OR complex of the LUMC, or online via Teams. All interviews took half an hour to an hour. Prior to the interviews, all interviewees gained an introduction into the reason and aim of the interview. Furthermore, an informed consent form was signed by all interviewees prior to the start of the interview. All interviews were recorded and transcribed, so that the complete answers given by the respondents could be used for analysis.

3.5.3. Analysis of the semi-structured interviews

All interviews were converted into transcripts, which were coded and analysed. For the coding, the indicators of the operationalisation were used, as well as additional codes. The analysis of the semi-structured interviews was therefore theme-based. A first round of descriptive coding was performed, meaning that pieces of text were summarised by its topic using a descriptive word. Pattern coding was performed in a second round, meaning that the descriptive codes were clustered into thematic codes. These thematic codes can be found in the coding tree in Figure D.1 in Appendix D. For these thematic codes, amongst others the indicators of the operationalisation were used. The pieces of text were categorised per code, and subsequently categorised per sub-question and worked out in the corresponding chapters.

4. Anesthesia assistants and their task of patient monitoring

In this chapter, the focus lies on the first sub-question of "What characterises the working environment of anesthesia assistants and what are their tasks and responsibilities at the OR?". Therefore, this chapter firstly discusses the working environment and OR team in which the anesthesia assistants work, in Section 4.1. Secondly, the education of anesthesia assistants is described in Section 4.2. Thirdly, Section 4.3 addresses the tasks of the anesthesia assistants, including the patient monitoring task and devices used in this task. Lastly, the workload and complexity of the tasks of anesthesia assistants is elaborated upon in Section 4.4. The results of the literature research and semi-structured interviews with anesthesia assistants are used throughout Chapter 4. All anesthesia assistants, and the anesthesiologist, that were interviewed are referred to as AM and a number from zero to seven: AM0 up to AM7, and AL and number 1: AL1.

4.1. Working environment and team

In the OR, surgeries of patients by an OR team take place. At the LUMC hospital, with 20 ORs, each year almost 15.000 surgeries are performed (Interview AM1; Leiden Universitair Medisch Centrum, n.d.). The LUMC hospital is an academic hospital, meaning that in contrast to peripheral hospitals, mostly specialistic, high complex, and lengthy surgeries are performed (Interview AM0). In peripheral hospitals, more emphasis lies on repetitively performing the same or similar operations, also called 'operation streets', with lower complexity and shorter durations (Interview AM0).

The OR is a complex, dynamic and high-risk environment, because of the high variety of patients and their conditions, and the high occurrence of unexpected events (Rathenau Instituut, 2020; Weller & Boyd, 2014; Göras et al., 2020). For that reason, the OR is regarded to be error prone (Weller & Boyd, 2014). The OR team that works at the OR during surgeries is a multidisciplinary team, consisting of at least one or multiple surgeons, two or three operation assistants, an anesthesiologist, and an anesthesia assistant (Capaciteitsorgaan, 2018). This team can be complemented by clinical perfusionists and/or co-assistants and one or multiple of previously mentioned staff members that are in training (Interview AM0). The composition of the OR team is not fixed and can differ per day (Interview AL1).

The anesthesia care team thus comprises at least one anesthesiologist and anesthesia assistant but is at the LUMC hospital, as being an academic hospital, often supplemented by an extra anesthesiologist in training and/or anesthesia assistant in training (interview AM1). A minimum of six people of medical staff is needed at the OR, but in an academic hospital usually eight to twelve people are present (interview AM1). Anesthesia care in the Netherlands is unique compared to other countries. In contrast to other countries, the anesthesia is seen as a collaborative team performance of the anesthesiologist and anesthesia assistant (Nederlandse Vereniging van Anesthesiemedewerkers. 2014; Interview AM1; Interview AM4).

The profession of the anesthesia assistant is not regulated within the statutory regulations of the Healthcare Professionals Act (Wet BIG), meaning that the anesthesia assistant is not authorised to independently perform their profession. However, the profession does fall within the scope of the law, resulting in anesthesia assistants being allowed to perform certain actions individually if other involved professionals have determined that they have sufficient competence to properly perform the task (Nederlandse Vereniging van Anesthesiemedewerkers, 2014). Because anesthesia assistants in the Netherlands are allowed and qualified to monitor the vital values of the patient and maintain the anesthesia, and if necessary, anticipate on the monitoring by intervening, it allows the anesthesiologist to divide his or her time over two patients at different ORs at once (Capaciteitsorgaan, 2018; Nederlandse Vereniging van Anesthesiemedewerkers. 2014; Interview AM1; Interview AL1). The anesthesiologist is present at the OR with the anesthesia assistant during the induction, bringing the patient asleep, and when waking the patient up. And they can be called any time by the anesthesia assistant in case of unexpected deviations or calamities, like major blood loss or airway problems (Nederlandse Vereniging van Anesthesiemedewerkers, 2014; Interview AM0; Interview AM1; Interview AL1). When an action needs to be taken, the anesthesia assistants do that within a number of agreed-on frameworks. If the performance of the action would be outside of these frameworks, that is only possible in consultation with the anesthesiologist (Interview AM1). In general, the anesthesia assistant has more knowledge on the machines, while the anesthesiologist has more medical knowledge (Interview AM2; Interview AL1). An anesthesiologist might intervene in the decision making and handling of an anesthesia assistant, and the anesthesiologist is the ultimate person to decide on the handling (Interview AM1). So, the final responsibility always lies with the anesthesiologist. However, the anesthesia

assistant is responsible for their own actions (Interview AM1; Interview AM7). Hence, conscious decision-making is essential, meaning that the development of anesthesia assistants towards deliberate professionals is important.

Surgeries involve a complicated labour division among the OR team members, that work together to complete the principal activity of the surgeon of operating the patient (Svensson, Heath & Luff, 2007). To provide effective, efficient, and high-quality care, collaboration and coordination are required, meaning that communication between other OR team members and anesthesia assistants takes place regularly (Nederlandse Vereniging van Anesthesiemedewerkers, 2014; Interview AM1). The collaboration in the OR team can be described as inter-disciplinary collaboration, where people from multiple disciplines integrate information to advance fundamental understanding and solve problems (Stokols, 2008). Surgeons, anesthesiologists, anesthesia assistants and OR assistants each perform their tasks based on their skills and knowledge, at the same time constantly sharing information, making decisions based on this information, and trying to make the operation successful while solving any issues or events.

Interactions back and forth between a surgeon and anesthesia assistant are necessary. The anesthesia assistant informs the surgeon on time on the condition of the patient. The reversed interaction is also important. For example, if the clamping of a blood vessel by a surgeon results in hemodynamic changes, then it is important for the anesthesia assistant to know the origin of these hemodynamic changes to prevent them to administer unnecessary medication (Interview AM1). However, these interactions are sometimes experienced as marginal by anesthesia assistants, resulting in that they experience changes in vital values without prior information by the surgeon. This partly has to do with the hierarchy in the OR team (Interview AM1). Also interactions between anesthesia assistants and operation assistants take place, helping each other when asked/needed (Interview AM1).

At the start of a surgery, the time-out procedure takes place with the whole OR team to ensure no mistakes are made. In this time-out procedure it is checked whether the patient is the right patient, what the roles of all team members are, whether it is the right type of surgery, which side of the patient is operated, whether the patient has allergies and if antibiotics have been given to the patient. Also, the presence of all materials and devices, and relevant co-morbidities and medical history of the patient are discussed (Interview AM0; Van Schoten et al., 2014).

This research focuses on the anesthesia assistants' working environment of the OR, but anesthesia assistants can also be working at other places than the OR, like in pre-operative screening and post-operative care as well as polyclinical pain management and sedation (Nederlandse Vereniging van Anesthesiemedewerkers, 2014). Furthermore, they are often involved in reanimations, in recovery rooms and delivery rooms, and in first care of traumatology patients, outside of the OR complex (Nederlandse Vereniging van Anesthesiemedewerkers, 2014; Interview AM1). In the pre-operative and post-operative care settings, the anesthesia assistants also come in contact with holding nurses that take care of the pre-operative care, and recovery nurses that are at the recovery room to perform the post-operative care (Interview AM0).

4.2. Education

The educational programme to become anesthesia assistant concerns an in-service training within an hospital of three years (Capaciteitsorgaan, 2018). The educational programme must be recognised by the College Ziekenhuizen Opleidingen, which is the case if it meets the requirements that are nationally determined by professionals and trainers from the field (Nederlandse Vereniging van Anesthesiemedewerkers, 2014). One has to apply for an apprenticeship at a specific hospital, and one must at least have graduated havo at high school (Interview AM0).

The in-service training starts with a career-preparatory period of at least 12 weeks, after which the anesthesia assistant in training is a work-student, meaning that they combine theoretical studying with working as anesthesia assistant (Nederlandse Vereniging van Anesthesiemedewerkers, 2014). The educational institute connected to the LUMC provides the theoretical part of the education (Interview AM5). The LUMC hospital provides training places for anesthesia assistants in training (Leids Universitair Medisch Centrum, 2020).

As one can start the in-service training to become an anesthesia assistant not only after graduating havo, but also after a finished hbo nursing education, anesthesia assistants sometimes are also qualified nurses, but not necessarily (Interview AM0).

To keep everyone widely employable, there are no specialisations for anesthesia assistants at the LUMC hospital. Only one difference can be distinguished, namely the difference between youngest anesthesia

assistant and oldest anesthesia assistant. Youngest anesthesia assistants are those that just graduated, and the dividing line is that they do not perform pediatric heart operations (Interview AM1).

After the educational programme, there are refresher courses for working anesthesia assistants. At the LUMC hospital, a special team called 'Learning and developing' is set-up to arrange the refresher courses for anesthesia assistants within the LUMC hospital (Interview AM1; Interview AM6; Interview AM7). This includes amongst others a talk about the introduction of a new device, equipment training, or e-learnings on certain medication (Interview AM6; Interview AM7).

All refresher courses take place per profession, meaning that there are no general refresher courses for the whole OR team. However, once in a while group crew resource management training takes place, to train for acute situations like reanimations (Interview AM1).

4.3. Tasks of anesthesia assistants, and devices used in patient monitoring

The exact tasks and responsibilities of anesthesia assistants can deviate between hospitals and is especially dependent on whether they work in an academic or peripheral hospital due to different distributions of tasks and responsibilities (Nederlandse Vereniging van Anesthesiemedewerkers, 2014). This is caused by the fact that in an academic hospital, more specialistic and highly complex procedures are performed than in a peripheral hospital (Interview AM0).

In the LUMC hospital, the working day of an anesthesia assistants starts with making sure all equipment and materials are present at the OR and that they have been checked, before the patient arrives. This means that the ventilator and monitor are switched on and checked, and all medication, breathing tube and cap, various filters and tubes are prepared and laid out, and potentially blood must be ordered (Interview AM0; Interview AM1). The patient is picked up by the anesthesia assistant in the preoperative holding area, where the patient data are checked with the patient or the holding nurse (Interview AM0; Nederlandse Vereniging van Anesthesiemedewerkers, 2014). The anesthesia assistant also has a task in reassuring patients if they are nervous or scared, and explaining them what is going to happen (Interview AM0). When the patient and whole OR team is present at the OR, the time-out procedure takes place. Subsequently, the anesthesia assistant and anesthesiologist perform the induction, in which the patient is put to sleep, together. This is done either intravenously or via vapor anesthesia (Interview AM0). For some operations, the patient only needs local anesthesia, which always happens intravenously (Interview AM0). Also, the monitors and ventilators are set. In general, after this, as the patient is asleep and the operation starts, the anesthesiologist leaves the OR (Interview AM1). Then, the anesthesia assistant mostly works independently (Interview AM5).

During the operation, the anesthesia assistant is continuously monitoring the vital parameters of the patient (Interview AM0; Interview AM1), as visualised in Figure 11. This actually even starts before the start of the operation, from the moment that the patient is connected to the monitoring devices, and ends when the patient is taken to the recovery room (Interview AM6). There are four monitoring pillars within the anesthesiology: sleep, pain relief, muscle relaxation and suppression of the autonomic nervous system (Interview AL1). The sedation, pain relief, muscle relaxation and suppression are performed by means of medication. Suppression of the autonomic nervous systems comprises amongst others the blood pressure and rate of breathing. For that reason, amongst others the ventilation of the patient is continuously monitored and kept in balance by the anesthesia assistant, according to the conditions that have been discussed with the anesthesiologist prior to the surgery (Interview AM1).

Figure 11. Patient monitoring as performed by the anesthesia assistant at the OR. Adapted from (EMY Commerce, 2020). The anesthesia assistant performs the anesthesia care. The anesthesia assistant keeps an eye on the (Philips) monitor in which the values of the vital parameters of the patient are shown. On the right, the ventilation machine is visible. Behind the sterile drapes, the surgeon and operation assistants are performing the surgery on the patient.

All measurements that are performed are visible in Table 1. Most measurement devices are integrated into the Philips monitor. This monitor is a sort of collection box, and modules of different stand-alone devices can be clicked in on the monitor, by which the monitor can register the measurements of the vital parameters by the devices (Interview AM1). Anesthesia assistants can set alarms on the monitor, based on the minimum or maximum values of the vital parameters they want for a certain patient. There are standard limits per vital parameter, but anesthesia assistants can change these alarms according to the situation of the patient and their preferences (Interview AM1; Interview AM4).

Table 1. Devices used for measurement in anesthesia at the OR, and the measured vital parameters by these devices. Input: (Interview AM0; Interview AM1; Interview AM2; Interview AM6; Interview AM7; Interview AL1; Lee et al., 2019; Silva & Rocco, 2018; Schuller et al., 2015; Anesthesiologist LUMC, personal communications, May 1, 2022; Anesthesia assistant LUMC, personal communications, May 6, 2022).

Device used for measurement	Measured vital parameter	Extra information
Electrocardiogram (ECG) (5-point)	Heart rate (heart beat frequency)	The 5-points ECG can also fairly reliable visualise the changing of the ST-segment compared to the beginning
Hemodynamic monitoring **- Inflatable blood pressure cuff (non-invasive, minimally once per 5 minutes, if required once per 2,5 or 3 minutes)** **- blood pressure transducer, via arterial catheter (invasive, continuously)**	Blood pressure	- Continuous blood pressure measurement is needed for certain surgeries, for example those in which a lot of blood loss is expected, those with large volume changes as major vascular surgery, and those in which frequent intra-operative blood sampling takes place - sometimes in bigger operations also the central pressure in the large blood vessels is invasively measured, which tells you the cardiac output, cardiac index and the pulse pressure variation

		which says something about the fluid status, but is used increasingly less because of a lower reliability - very rarely, the Swan Ganz is used to measure amongst others the pressure in the pulmonary artery
Ventilation machine (Primus, firm: Dräger)	Many parameters are collected by the ventilation machine, the most important ones are: - fraction of inspired oxygen (O_2) - fraction of expired oxygen (O_2) - fraction of expired carbon dioxide (CO_2) via capnogram - respiratory minute volume - tidal volume - respiratory rate (breathing frequency) -I:E ratio; the ratio between the time of inspiration (I) and expiration (E) - expired anesthetic vapours, such as sevoflurane *Pressures in the lungs:* - positive end-expiratory pressure - inspiratory pressure - peak pressure	The anesthesia assistant can adapt every value in case needed for the patient.
Pulse oximeter	Oxygen saturation level in the blood	The pulse oximeter is an infrared finger cuff that measures how much oxygen is bound to hemoglobin in the blood, by means of 2 pulse measurements. It sends infrared light with 2 wavelengths through the finger. One wavelength measures hemoglobin without oxygen and one hemoglobin with oxygen. Subsequently, the amount of oxygen bound to hemoglobin can be measured with the help of Lambert-Beer's law. *Disadvantage:* the pulse oximeter is very sensitive to movement and does not work with any form of nail polish. It is also possible to measure the saturation through the earlobe.
ToFScan NMT-monitor (Train-of-Four-monitor)	Neuromuscular tension	The ToFScan NMT monitor gives four stimuli, measuring the neuromuscular transmission, which is the signal that muscle fibers send to activate and relax muscles. The neuromuscular transmission can be blocked with medication, to prevent movement of the patient or if needed to open the vocal cords for intubation. However, neuromuscular relaxation in combination with the waking up of a patient should be prevented. One can also measure the post tetanic count which is a more intense measurement with 15 stimuli to indicate the depth of a deep neuromuscular blockade.

BIS monitor	The level of consciousness: depth of the anesthesia	The EEG detects abnormalities in the brain waves or in the electrical activity of the brain. The electromyography (EMG) measures the electrical activity of a muscle as response to the stimulation by a nerve. The measurements of the activity in the EEG, combined with measurements of the EMG as these often affect the BIS values, are used by the BIS monitor to calculate BIS values using a patented algorithm. The BIS values display the level of consciousness, or depth of anesthesia, of the patient in the last 15 to 30 seconds. The output is a value between 0 and 100, with the patient being awake at 100. The value should ideally be kept between 40 and 60.
Thermometer	Body temperature	
Calculated by HIX-system	Fluid balance	Calculated by the HIX system (hospital information system used in the LUMC) after manually noting down all fluids that are given to the patient, including blood, and lost by amongst others urine.

The anesthesia assistant takes more factors into account for the monitoring of the patients' wellbeing than the vital values on the monitor, by looking, listening, and feeling (Interview AM0; Interview AM1; Interview AM3; Interview AM4; Interview AM5; Interview AM7). Amongst others by checking the sweating, breathing, and pupils of a patient, and looking at the surgeon to determine the phase of the surgery. This all gives information, which ultimately leads to the decision of an anesthesia assistant on what to do (Interview AM1). The clinical view on the patient is even considered more important than the monitoring, according to some anesthesia assistants (Interview AM3; Interview AM4). Additionally, the listening to the monitors is a special skill of anesthesia assistants, registering changes in rhythm or height of sounds (Interview AM0; Interview AM3; Interview AM7).

The anesthesia assistant must anticipate on changings in the vital values and state of the patient, such as a change in blood pressure values, by administering medication to maintain the anesthesia and keep all vital values at a good level (Interview AM1; Interview AM6; Interview AM7). The monitor values of different vital parameters are constantly linked to be able to understand the situation and assess the reliability of the parameter values, the seriousness of the situation, and the actual and potential consequences of the disturbed parameters (Nederlandse Vereniging van Anesthesiemedewerkers, 2014; Interview AM6). Which values are best is dependent on the type of surgery and the patient, such as the difference between a child and an adult, but also within patient categories there can be major differences (Interview AM0).

Intervening is always based on unwritten, mutually agreed-upon protocols. For example, it could be agreed in advance that the mean arterial pressure must stay above 65 mmHg. If the value drops below 65, the anesthesia assistant can administer the patient with a blood pressure raising medication, as Ephedrine, Phenylephrine, or Noradrenaline. However, which medication is chosen is not pre-arranged, and takes place on the basis of the experience and knowledge of the anesthesia assistant (Interview AM1). For example, as Ephedrine is known to speed up the heartbeat, it is often chosen as blood pressure raising medication if the low mean arterial pressure of the patient goes together with a low heartbeat (Interview AM1; Apotheek.nl., 2020). Deviations from these unwritten protocols always takes place in consultation with the anesthesiologist (Interview AM1).

Medication is mostly given via the intravenous drip. These infusion pumps are of the firm Acromed and have no registration coupling with the Philips monitor: all information about this should be noted down in the HIX system by the anesthesia assistant (Interview AM1). The HIX system is the hospital information system used by the LUMC. This way, amongst others medication for sleeping, pain relief, neuromuscular relaxation, and blood pressure regulation are administered to the patient (Interview AM2).

Nowadays, all registration and documentation tasks surrounding the monitoring are taken over by the Philips monitor, that will send all information to the electronic patient record system, meaning that anesthesia assistants do not have to write down the vital values of amongst others the heartbeat every five minutes anymore (Interview AM0). However, all medication that is administered to the patient must be registered by the anesthesia assistant, while performing other tasks (Interview AM1). The documentation burden is considered low, especially compared to the documentation burden on a nursing ward, but is sometimes still experienced as annoying because it can take a lot of time at busy moments (Interview AM0; Interview AM1; Interview AM2).

At the end of the surgery, the anesthesia assistant ensures together with the anesthesiologist that the patient will wake up again, by administering medication to the patient. Knowledge of medication is necessary, for example to prevent that people wake up while their muscles are still relaxed (Interview AM0). The anesthesia assistant and/or anesthesiologist brings the patient to the recovery room where the patient is transferred to the recovery nurses, while giving information about the procedure, whether there were any problems, and which medication was given that will affect the patient at the recovery room (Interview AM0).

4.4. Complexity of the tasks of anesthesia assistants

Multiple aspects in the working environment, as well as general developments, impact the workload and tasks of anesthesia assistants. The workload of anesthesia assistants is impacted by developments in healthcare. Five developments have caused this workload to rise.

Firstly, there is a shortage in all medical support staff, which will only increase in the coming years (Dreessen & Hoorn (LVO), 2012; Nederlandse Vereniging van Anesthesiemedewerkers, 2014). This is caused by staff loss, as 10% of the amount of full-time equivalents among anesthesia assistants is over the age of 60 and will retire in the coming years, a too small influx of anesthesia assistants, while a yearly growth of 1.0% of anesthesia assistants is needed to meet the demographical care-demand in the Netherlands in the coming years (Capaciteitsorgaan, 2018).

Secondly, the job of the anesthesia assistant is experienced as physically and mentally demanding and includes long working days along with evening and night shifts (Lupke, 2019). Anesthesia assistants are busy all day performing operations, preparing, cleaning up, and guiding patients, but also have very calm moments (Interview AM1; Interview AM4; Interview AM5). Anesthesia assistants sometimes experience frustration due to the rush that comes with their profession (Interview AM0; Interview AM4). The job necessitates both technical knowledge of the machines as well as a significant human element in reassuring the patient and teamwork with the OR team, and it carries a high level of responsibility as anesthesia assistants are expected to respond to acute changes in the patient's vital functions as these can be life threatening (Nederlandse Vereniging van Anesthesiemedewerkers, 2014). Due to a shift of tasks from the anesthesiologist to the anesthesia assistant and the increase in the number of tasks of anesthesia assistants related to amongst others the managing of medical devices and supplies, the workload increases even more (Capaciteitsorgaan, 2018).

Thirdly, there is a rise in the number of highly complex operations, making the anesthesiological care demand more complex and intensive (Nederlandse Vereniging van Anesthesiemedewerkers, 2014). Highly complex operations are the result of patient complexity, due to amongst others an ageing society and multi-morbidity, and procedure complexity, on which the increased use of (complex) protocols and new operation techniques are of impact (Capaciteitsorgaan, 2018; Dreessen & Hoorn (LVO), 2012).

Fourthly, the increasing use of technology in the OR, in the form of amongst others medical devices and information technology, is creating a more complex working environment for anesthesia assistants at the OR (Aggarwal et al., 2010).

And finally, there is also a push to perform every treatment as effective and efficient as possible to reduce the costs. At the same time, the safety and quality regulations have become stricter (Nederlandse Vereniging van Anesthesiemedewerkers, 2014).

The work of anesthesia assistants in the OR is thus complex and dynamic, constantly preparing for and managing expected and unexpected events, while meeting requirements of quality, safety, and time-constraints. For that reason, the team and individual team members must have plans on how to deal with certain complex situations, and always be mentally prepared for situations to happen. Upcoming problems must be prioritised and solved accordingly (Göras et al., 2020). The anesthesia assistant must constantly seek for information to assess the situation and reaffirm whether one has the correct information and plan in mind.

There are various other factors that contribute to the complexity of anesthesia assistants' tasks. Firstly, the history of the patient and the fact that every patient reacts differently on the anesthesia makes the work complex (Interview AM1; Interview AM2). A patient that is considered high-complex before a surgery can appear to give no problems, while another low-complex patient results in major problems with for example blood pressure regulation (Interview AM2). The complexity of the monitoring is dependent on the casus as well as the situation (Interview AM2).

Secondly, a factor that contributes to the complexity is the increasing role of evidence based practice within healthcare, meaning that anesthesia assistants have to substantiate and justify their actions based on scientific research insights next to the use of their own judgement based on clinical experience and taking into account the preferences of the patient (Nederlandse Vereniging van Anesthesiemedewerkers, 2014). According to AM1, many decisions are based on experience and gut feeling. You never know the exact amount of medication you have to administer to the patient, as every patient reacts differently to the drug, and therefore you constantly have to balance the amount of drugs given (Interview AM1).

Thirdly, there is "noise" in the monitoring of vital parameters. This could amongst others be the result of a moving patient, which might change values like the blood pressure, or measurement devices that do not function as desired, like a pulse oximeter that constantly is giving a wrong value (Interview AM1; Interview AM4; Interview AM6; Interview AM7; Interview AL1). The result is that anesthesia assistants or anesthesiologists often widen the alarm limits or even put them down (Interview AM1; Interview AL1).

Fourthly, sometimes there could be multiple reasons why certain vital values change. If a surgeon blows carbon dioxide into the belly of the patient, to create more space for the operation, this will increase the blood pressure of the patient. Mostly, a rise in blood pressure is a sign of pain, but in this case, it could also be the effect of the carbon dioxide inflow (Interview AM0; Interview AM1; Interview AM6). In the same way, blood pressure may drop as a result of blood loss, but also due to opioid overdoses, which makes it hard to determine what the cause of the blood pressure drop is (Interview AM1). It also affects the ventilation of the patient, as the carbon dioxide creates counter-pressure on the lungs (Interview AM0).

On the other hand, the monitoring task is not considered complex by some of the anesthesia assistants, as there are relatively little parameters. There are agreed-on normal values and limits for alarms that you must hold on to (Interview AM1). Furthermore, it is also dependent on the anesthesia assistant whether they experience it as complex (Interview AM2).

5. Possibilities in AI-assisted monitoring

This chapter focuses on the second sub-question "What AI possibilities are there in the monitoring task of anesthesia assistants, and the prediction of risk factors?". This chapter firstly states the definition of AI in the context of this study (Section 5.1). Subsequently, it discusses some technologies that are in use at the OR that have overlapping areas with AI (Section 5.2). Thereafter, the current developments of AI for patient monitoring at the OR are described (Section 5.3). Finally, the range of options for the implementation of AI-assisted monitoring in anesthesia at the OR are discussed (Section 5.4).

5.1. Definition of AI in this context

As described in Section 1.1, AI employs a combination of computer science and enormous datasets to mimic human thinking in reasoning and learning, to assist in problem-solving and decision-making (Rong et al., 2020; Matheny et al., 2019). Algorithms are used to enable machines to reason, learn, solve problems, and make decisions (Birkhoff, van Dalen & Schijven, 2021).

There are different forms of learning that can be applied in AI. The simplest form is when the computer tries different options until the correct solution is found, which is subsequently saved by the computer and can be used directly in a future occurrence of the same problem. More complex is generalisation, in which the learned past experiences are applied in new situations. In reasoning, inferences are drawn from the situation, which can be either inductive or deductive. In deductive reasoning, the computer can logically draw a conclusion based on the data. In inductive reasoning, observations are made by the computer, after which a prediction of a conclusion is made based on the observations, but there is no assurance that the conclusion is right (Copeland, 2022).

AI is an umbrella term, and there are different subdomains to be distinguished such as machine learning, artificial neural networks, computer vision, and natural language processing (Birkhoff, van Dalen & Schijven, 2021; McGrow, 2019; Shaw et al., 2019). AI can be used in many fields within healthcare, in various forms and applications. The applications of AI for patient monitoring in anesthesia in the OR focus mainly on machine learning (Mathis, Kheterpal & Najarian, 2018). In machine learning, statistical models are generated automatically, or semiautomatically, from data based on a set of criteria (Shaw et al., 2019). Whereas normally in AI, the programmer establishes in advance how the computer can solve the problem, in machine learning, the programmer establishes how the computer can find the solution by itself (H. Jessen, MSc Artificial Intelligence, personal communications, May 3, 2022). A machine learning algorithm is defined as a collection of instructions that a computer follows to learn from the data set (Lum & Chowdhury, 2021). The machine learning algorithm is trained on data, and the result is a machine learning model that represents the well-defined rules to make predictions with new data (McGrow, 2019). The machine learning model can make predictions based on previous data, in this case data of earlier performed surgeries as well as patient data like medical history and body mass index (BMI) (Mathis, Kheterpal & Najarian, 2018; Shameer et al., 2018; T. Vijfvinkel, PhD candidate TU Delft, personal communications, January 13, 2022). The models may then improve over time by learning through training (Stewart, Sprivulis & Dwivedi, 2018). Thus, without explicit programming, the models will improve in the performance of their tasks.

Within machine learning, there are different categories of algorithms. The main categories are supervised learning, unsupervised learning, semi-supervised learning, and reinforcement learning (Tekkeşin, 2019; Johnson et al., 2018; Shaw et al., 2019). In supervised learning, the data set is labelled, which entails that the labels at the data points indicate what the data means. Then, the machine learning algorithm is trained on labelled data, which could for example be a blood pressure measurement over time where the hypotension and hypertension events, as well as no events, are labelled, and the model can subsequently determine for a new data point which label it matches (Shaw et al., 2019). For the prediction of events, this would mean that the algorithm directly knows that a certain deviation leads to the occurrence of a certain event (H. Jessen, MSc Artificial Intelligence, personal communications, November 24, 2021). In unsupervised learning, the data algorithm is trained on unlabelled data, and the model must learn to identify the deviations in the data by itself, as well as recognise where there is an association between a certain deviation and a certain event and so recognise the patterns in the data (Johnson et al., 2018; Shaw et al., 2019; H. Jessen, MSc Artificial Intelligence, personal communications, November 24, 2021). Semi-supervised learning is something in between supervised and unsupervised learning, meaning that only a part of the data is labelled (Fumo, 2017). The machine learning model could also undertake actions, such as recommending treatments. The algorithm learns through trial and

error, by trying different actions and by gaining and processing feedback from its environment, or interpret the user, in this case the anesthesia assistant. This way, the algorithm improves in taking the right actions. This is called reinforcement learning (Shaw et al., 2019; Johnson et al., 2018).

There are also many different options in the set-up of an algorithm, such as the choice to optimise the amount of certainty in predictions (Shameer et al., 2018; H. Jessen, MSc Artificial Intelligence, personal communications, November 24, 2021). For the prediction of events in the monitoring of a patient during anesthesia, it is important that no events are missed. This means that the reduction of the amount of false negatives is important, but on the other hand might it also be important to reduce the amount of false-positive events to prevent the occurrence of alarm fatigue (H. Jessen, MSc Artificial Intelligence, personal communications, November 24, 2021). Reducing the amount of false negatives is difficult due to the fact that there is a class imbalance in the previous surgery data, as the occurrence of certain events in previous surgery data is small. This could lead to a model to predict that no event will take place, with a high accuracy. However, a model can be trained in such way that extra weight is given to the data in which the event took place (H. Jessen, MSc Artificial Intelligence, personal communications, November 24, 2021).

This way, algorithms can be developed to for example make predictions on events during surgeries of patients at the OR, such as blood pressure drops, or predict whether and how much medication is needed for a patient (T. Vijfvinkel, PhD candidate TU Delft, personal communications, January 13, 2022). Within the patient monitoring task, AI could thus specifically support anesthesia assistants with the interpretation of the values of the vital parameter measurements and by drawing conclusions from these values. Which results in the prediction of the occurrence of certain events that could harm the patient, as well as predictions on the amount of medication that needs to be administered at a certain point in time. This form of intelligent clinical monitoring allows for the early detection of patients who are deteriorating (Stewart, Sprivulis & Dwivedi, 2018).

In patient monitoring, anesthesia assistants normally read, integrate, and interpret the vital parameter values of the monitor, and draw conclusions from that by clinical reasoning, potentially leading to clinical intervening. AI can be of advantage in patient monitoring at the OR, as it can extract the relevant information from the real-time data indicating the occurrence of events, based on the data AI is trained upon. This helps the anesthesia assistants to make informed decisions during the surgery (Asan, Bayrak & Choudhury, 2020). But, as anesthesia assistants are specifically trained for this task, replacing part of their task with an algorithm comes very close to their profession.

The definition of AI in monitoring used in this study, which was also discussed with anesthesia assistants in the semi-structured interviews, is focused on the clinical actions in patient monitoring. Namely, that AI can be seen as a computer that contains a lot of data. This data consists of measurements of vital parameters of patients in performed surgeries, and patient data, such as weight, BMI, comorbidities, and medical history. The vital measurements that are obtained in real-time during a surgery can be compared with the data that have been collected during previous surgeries, and the patient data of the current patient can be included in this. For example, the computer contains data of multiple surgeries in which a sudden low vital value, such as blood pressure, led to a certain event. If these same measurements are registered by AI in the current patient, AI can warn that one needs to be alert for some specific event or that certain medication is needed. Even a barely noticeable change in for example a blood pressure line can be recognised by AI this way, thereby warning for an event such as a severe blood pressure drop, that could occur in a certain time span such as ten minutes.

5.2. Current technologies with overlapping areas with AI

Although there is no AI implemented in the OR yet, many technologies are incorporated in the OR. At least two of the devices that are used in the OR to perform the vital parameter measurements, have overlapping areas with AI, by using algorithms. Namely, the BIS monitor and the Finapres pulse oximeter. This kind of devices show the difficulty of the distinction between AI and technology, as the simplified definition of a computer that uses an algorithm is insufficient. The boundary between AI and technology is often more strictly adhered by AI developers than by OR staff. In this study, the subsequent two devices are seen as technology, and not as AI, in accordance with AI-developers. However, the example of the BIS monitor can be used to simplify the explanation of what algorithms and AI mean. Furthermore, these measurement devices both have time delays in their predictions. Measuring depth of anesthesia or oxygen saturation level devices might be improved by the use of AI in the future.

The BIS monitor monitors the depth of anesthesia at the patient during the surgical procedure, by collecting EEG data through sensors on the patients' forehead. These sensors pick up the electrical signals that are produced by the brain of the patient, and the BIS monitor processes and analyses the EEG signals using an algorithm to calculate BIS values (Mathur et al., 2021). Monitoring the depth of anesthesia during surgery is important because it decreases the changes of too light or too deep anesthesia (Medical Advisory Secretariat, 2004). Too light anesthesia may lead to intraoperative awareness among patients and too deep anesthesia may lead to hemodynamic changes (Mathur et al., 2021). Because the BIS is affected by muscle activity, also measurements of the electrical activity of a muscle as response to nerve stimulation by EMG are incorporated in this calculation (Schuller et al., 2015; Anesthesiologist LUMC, personal communications, May 1, 2022). The BIS value indicates the depth of anesthesia, or represents the state of consciousness of the patient, in the last 15 to 30 seconds. The output is a number on the scale of 0 to 100, with 0 indicating that there is complete suppression of EEG-activity in the brain and 100 that the patient is awake, to be ideally kept between 40 and 60 during a surgery (Vuyk, Egberink & Burm, 2004).

Research by Ferreira et al. (2019) shows that although the manufacturer indicates a five to ten seconds processing time delay, the average time delay of the BIS monitor comprises 30 seconds (Ferreira et al., 2019). Additionally, from a literature review on the impact of BIS monitoring by the Medical Advisory Secretariat, the Medical Advisory Secretariat concludes that the algorithm used in BIS monitoring can indicate reasonably correct whether the patient is alert, but the unconscious state of the patient cannot be accurately predicted (Medical Advisory Secretariat, 2004).

5.3. Research on contemporary developments of AI for monitoring at the OR

The AI applications for anesthesiology in the OR are still in the research and development stage (Hashimoto et al., 2020; Rush, Celi, & Stone, 2019). Research on contemporary developments in AI, and more specifically the developments for the monitoring of patients and prediction of risk factors, are discussed in this section. What makes it difficult to really discover the effectiveness of these forms of AI-assisted monitoring, is that the model cannot function equally in research and in practice, as the model will become more effective if it is incorporated in practice by constantly learning and updating its set of instructions based on new data of surgeries (Rush, Celi, & Stone, 2019).

A review on the research performed on the intersection between AI and anesthesiology is carried out by Hashimoto et al. (2020) (Hashimoto et al., 2020). Six different themes were identified in this scoping review, of which the depth of anesthesia monitoring, event and risk prediction, and the control of anesthesia delivery are related to patient monitoring (Hashimoto et al., 2020).

The research on the use of AI in the depth of anesthesia monitoring, focuses mainly on the use of the BIS or EEG. Machine learning can be used to analyse complex data as the EEG and this way measure the depth of anesthesia in the patient (Hashimoto et al., 2020). Research by Mirsadeghi et al. (2016) shows that a machine learning method that analyses the EEG can be used to determine whether a patient is awake or in an anesthetised state, with an accuracy of 88.4% in contrast to an accuracy of 82.4% of the BIS index (Mirsadeghi et al., 2016). Also, the research by Gu, Liang & Hagihira (2019) uses the combination of multiple EEG-based features as monitoring system to determine the depth of anesthesia in a patient (Gu, Liang & Hagihira, 2019). Similarly, research by Shalbaf et al. (2018) uses an algorithm that is able to distinguish between awake, light, general, and deep states of anesthesia in a patient. Different accuracy rates are reached dependent on the medication used for anesthesia, for instance a 93% accuracy rate was reached while using propofol as anesthetic versus an 87% accuracy rate of the BIS index (Shalbaf et al., 2018). In other studies, also other clinical signals as heart rate variability than the BIS and EEG were used to measure the depth of anesthesia in patients (Hashimoto et al., 2020). For example, by the use of measurements of blood pressure and heart rate, as in research by Ranta, Hynynen & Räsänen (2002). Although the models could not reliably observe awareness in the patient, they showed that in general the blood pressure and heart rate of patients with awareness is higher than without awareness (Ranta, Hynynen & Räsänen, 2002).

On the topic of event and risk prediction during operations, multiple studies are performed (Hashimoto et al., 2020). The prediction of hypotension through machine learning is one example of an AI development for patient monitoring in the OR that is being researched. Developing a hypotension probability indicator algorithm and training it with large data sets of records of arterial waveforms of patients during surgery, enables the algorithm to learn to detect the deviations in arterial pressure waveforms that lead to hypotension (Hatib et al., 2018). These data sets must include the occurrence of intraoperative hypotensive events, meaning that the

arterial pressure of the patient drops below 65 mmHg. The algorithm is then able to recognise patterns in the arterial waveform recordings. With that, it may identify early alterations in the arterial pressure waveforms of new data and predict a hypotensive event of the patient during surgery 15 minutes in advance, according to research by Hatib et al. (2018) (Hatib et al., 2018). By using the arterial line waveform to predict hypotension, Hatib et al. (2018) go beyond the simpler characteristics of blood pressure and heart rate (Mathis, Kheterpal & Najarian, 2018). Likewise, Kendale et al. (2018), tried varying supervised machine-learning classification techniques to predict hypotension in the first ten minutes after anesthesia induction. They found out that the machine-learning methods that were better in handling class imbalance had a better performance (Kendale et al., 2018). However, the performance of their model was still far from perfect (Mathis, Kheterpal & Najarian, 2018). Another research is performed by Lundberg et al. (2018) on the use of a machine-learning-based system that can predict intraoperative hypoxemia, meaning below-normal levels of oxygen in the arteries that can cause serious patient harm (Lundberg et al., 2018). Data of over 50.000 surgeries were used to train the machine-learning algorithm to predict hypoxemia events and help in medical decision making (Lundberg et al., 2018; Yu, Beam & Kohane, 2018). Furthermore, this research describes the complexity of the choice between models that are simpler interpretable but at the same time sacrifice on accuracy, and complex but more accurate models. Complex, accurate models are difficult to implement at the OR, as the predictions are not interpretable and explainable by clinicians. Hence, they suggest providing explanations of the patient and surgical risk factors that may result in the event, while using the more accurate model, resulting in an increased anticipation on hypoxemic events (Lundberg et al., 2018). Another example of AI to predict the occurrence of events in vital parameters is the research by Guillame-Bert et al. (2017) on the prediction of cardiorespiratory instability in continuously monitored patients outside of the OR using a machine learning algorithm. This results on average in the prediction of a cardiovascular instability event around 18 minutes before its occurrence (Guillame-Bert et al., 2017).

The LUMC itself also performs research, such as on the HemoSphere of the firm Edwards, both inside the OR as outside of the OR in a test lab (Interview AM7; Personal observation, February 28, 2022, Test Lab and Operating Room at LUMC). This HemoSphere uses an algorithm and Hypotension Prediction Index software to predict hypotension in patients (Interview AM1; Edwards Lifesciences Corporation, 2022).

The control of anesthesia delivery is another subject on which research is being performed. Control systems in anesthesia can result in automated delivery of medication for anesthesia or infusions (Hashimoto et al., 2020). They aim at lowering the workload of the anesthesia care team, raising the favourable clinical state time, and with that improve the quality of the anesthesia care and safety of the patient (Dumont & Ansermino, 2013). For these automated feedback control systems, measurement of vital parameters as the depth of anesthesia are necessary (Hashimoto et al., 2020; Dumont & Ansermino, 2013). Zaouter et al. (2016) researched the feasibility of a completely automated anesthesia drug delivery system by infusion in cardiac surgical procedures, resulting in a success rate in 80% of patients, with a satisfactory clinical performance in the control of anesthesia (Zaouter et al., 2016).

Also, a closed-loop control system for neuromuscular blockade was researched by Lendl et al. (1999), which calculates the amount of medication needed to maintain the neuromuscular blockade and directs the infusion pump to administer the drug (Lendl et al., 1999). Likewise, the clinical usability of a model-based control system to adjust the mechanical ventilator based on the measurement of the fraction of carbon dioxide emitted at the end of the exhale of a breath was researched by Martinoni et al. (2004). Their research showed good reaction of the model to setpoint changes as well as artefacts (Martinoni et al., 2004).

5.4. Support versus take-over

In most studies in Section 5.3, the focus lied on how AI could help the anesthesiologic clinical practice by improving the workflow and clinical decision making, but some also head towards replacement of the clinician (Hashimoto et al., 2020). By using reinforcement learning, it could also be possible that interaction between AI and anesthesia assistants would take place in the future. The prediction for a certain event would lead to the recommendation of the model for a certain treatment, and this reinforcement learning model could learn from the anesthesia assistant by learning and improving based on whether the anesthesia assistant uses the treatment recommendation at that moment, or not. It could then even be the case that the algorithm performs the task of delivering medication to the patient and learning to perform this task optimally through gaining feedback from the vital parameter values and/or anesthesia assistant (Hashimoto et al., 2020; Padmanabhan, Meskin & Haddad, 2015; Lowery & Faisal, 2013; Moore et al., 2014; Orenstein, 2022; Schamberg et al., 2022).

This also means that AI could be adaptive to its environment, and therefore plastically deformable by the anesthesia assistant. This makes AI different from other, simpler, technologies.

Implementation of AI-assisted monitoring could thus take on different forms, on a scale from minor to major impacting the job of anesthesia assistants, see Figure 12. Left on the scale would be the anesthesia assistants getting suggestions by AI based on its predictions, which they can accept or not. In the middle of the scale would be that clinical advice would be automated. AI makes predictions as well as administers the medication to the patient, but both are checked by the anesthesia assistant that can intervene if necessary. On the right of the scale would be a full take-over of the anesthesia assistant by AI, where the anesthesia assistant may only be present in a room with cameras and can go to an OR if necessary.

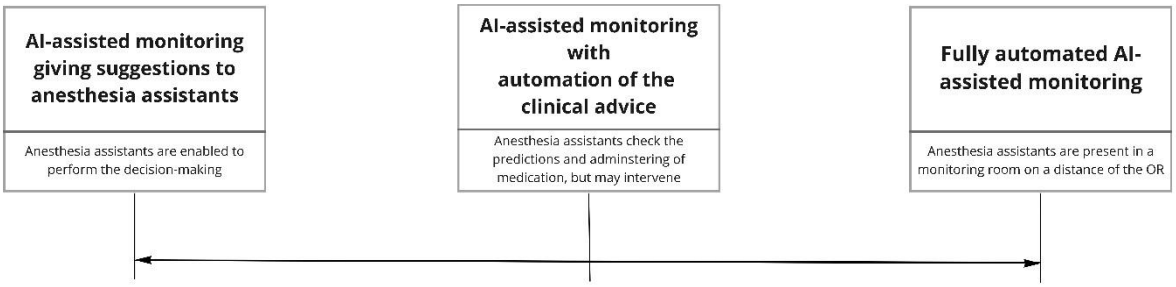


Figure 12. Forms of AI-assisted monitoring at the OR on a scale from minor to major regarding the impact on the job of anesthesia assistants (Own visualisation).

It is important to discuss the preconditions of the anesthesia assistants in connection with the use of AI-assisted monitoring in an early stage, as these are the medical support staff that will have to work with these systems (T. Vijfvinkel, PhD candidate TU Delft, personal communications, January 13, 2022). The anesthesia assistants know what requirements the system must meet, as well as know where on the scale they want AI to influence their work (see Figure 12).

6. Results: Perception and attitude of anesthesia assistants

This chapter contains the results of the semi-structured interviews with the anesthesia assistants regarding the questions on the perception and attitude (see the Operationalisation table in Appendix A). In this chapter, the focus lies on the third sub-question of "What is the perception and attitude among anesthesia assistants on AI possibilities in monitoring, and what are their preferences in the use of AI-assisted monitoring?". In Section 6.1 the perception of the anesthesia assistants of AI at the OR is discussed, covering their knowledge on AI possibilities at the OR, as well as their interest and expectations in AI at the OR. Section 6.2 elaborates on the attitude of the anesthesia assistants towards the use of AI-assisted monitoring in their task of patient monitoring, as well as their preferences and concerns regarding AI-assisted monitoring. Finally, in Section 6.3, a reflection on the results on perception and attitude is given.

Although among the interviewed anesthesia assistants were both men and women, all anesthesia assistants are addressed masculine in this chapter to ensure confidentiality. Additionally, all anesthesia assistants are referred to as a number from zero to seven: AM0 up to AM7.

6.1. Anesthesia assistants' perception of AI at the OR

This section describes the anesthesia assistants' perception of AI possibilities in the OR. Their knowledge of the AI potential in the OR is described, followed by their interest and expectations in the use of AI at the OR.

6.1.1. Knowledge of AI possibilities at the OR

From the interviews with anesthesia assistants, it appears that the subject of AI is mostly new to them. They hear relatively little about it in their job environment, while they mentioned it is becoming a big concept in society (Interview AM1; Interview AM7). On the OR-complex in the LUMC it is almost never a topic of discussion among anesthesia assistants or with other members of the OR-team (Interview AM2; Interview AM4; Interview AM5; Interview AM6). And if the topic of AI is discussed among themselves, it is often not that serious, like in situations of personnel shortage that they jokingly question whether they could replace staff by a robot. The topic soon comes to a halt since no one knows what the possibilities are (Interview AM4). Uncertainty and unclarity on the possibilities of AI at the OR are also mentioned by other anesthesia assistants (Interview AM1; Interview AM5). Another reason why the topic of AI might not be so alive among the anesthesia assistants is, according to AM1, because an anesthesia assistant is trained for this specific profession and the technical aspect is often a step further. Something that is a far from their bed show (Interview AM1).

"But I think it is just because we do not know what... What is out there. I think that that is what we are running into." (Interview AM5)

"Maar het komt denk ik gewoon omdat we niet weten wat er allemaal… Wat er is. Ik denk dat dat hetgeen is waar we tegenaan lopen." (Interview AM5)

Only some anesthesia assistant mentioned something AI-related at the OR. AM7 notices that a researcher was present a few times at the OR to try to predict hypotension on the basis of stroke volume variations, by the use of the HemoSphere monitor of Edwards (Interview AM7). However, this topic was then no longer further topic of discussion, as this anesthesia assistant never got any feedback about the results of this research (Interview AM7). AM1 also knows about the existence of this device and that it contains something that can predict; a Hypotension Prediction Index (Interview AM1). AM2 mentions the existence of the AI-related SmartPilot monitor of the firm Dräger. He thinks that it is involved in predictions on the amount of sleep and pain medication that are needed. But he knows that very little hospitals use this device (Interview AM2).

Other technical developments as new technical devices, on the other hand, are mutually discussed (Interview AM5; Interview AM2). AM2 mentioned that these technical developments are taught in lessons, sometimes by the firm that will come for a talk, and often an e-learning about the technical device is included too (Interview AM2).

6.1.2. Interest and expectations in possibilities of AI at the OR

Most anesthesia assistants that have no or little knowledge about AI and its possibilities within anesthesia at the OR, also clarified that they have no image or expectations about AI at all (Interview AM3; Interview AM4, Interview AM5; Interview AM6). AM2 also addresses that because of the lack of knowledge on the possibilities of AI, there is often no real expectation of AI in the OR among anesthesia assistants (Interview AM2).

"I think, if I may describe my average colleague, there is still too little knowledge about it, to have even thought about it to see whether it is applicable." (Interview AM2)
"Ik denk, als ik mijn gemiddelde collega mag omschrijven, is daar nog te weinig kennis over om daar überhaupt over nagedacht te hebben om te kijken of het toepasbaar is." (Interview AM2)

However, there does not seem to be a direct fear image of AI, as they work a lot with technical equipment, and something like a robot is not directly seen as different from a technical device (Interview AM4). AM4 and AM6 clarified that the topic of AI is actually really of interest and that they are curious on the possibilities of AI at the OR (Interview AM4; Interview AM6). Also among the other anesthesia assistants, there mostly seems to be quite some interest in AI for at the OR. For other colleagues, AM2 expects that the prerequisite must be that AI is more prevalent in practice at the OR in order to gain their interest (Interview AM2). However, it was also mentioned by AM7 that some older colleagues might not be very interested in the use of AI as they think it is not necessary to change something (Interview AM7).

"I do! And well, when I speak for my colleagues, I assume that there is more interest in that." (Interview AM5)
"Bij mij wel! En nou, als ik voor mijn collega's spreek, daar ga ik wel van uit dat daar meer interesse voor is." (Interview AM5)

"But I really like it myself and I know a lot of my young colleagues also like it a lot. And I think that the somewhat older colleagues would really not be open to that. Those will think that it is not necessary at all. I work for another 10 years. I like it this way." (Interview AM7)
"Maar zelf vind ik het wel echt heel leuk en ik weet ook veel van mijn jonge collega's vinden het ook heel leuk.
En ik denk dat de wat oudere collega's daar echt niet voor open staan. Die denken van het hoeft allemaal niet. Ik werk nog 10 jaar. Ik vind het wel goed zo." (Interview AM7)

Contradictory, AM2 and AM7 do have expectations about AI. And even though AM6 mentioned to not have any image about AI at the OR, still some ideas popped up, like the option to use voice recordings to change pump settings (Interview AM6), which could be achieved by natural language processing. However, AM6 also mentioned that this would give risks as there are a lot of disturbing noises at an OR (Interview AM6). AM7 thinks that AI will be very valuable for the profession of anesthesia assistant. He sees AI in the OR just like a self-driving car, in which the computer watches for you, but warns you if you must intervene (Interview AM7).

"So, just like the self-driving car, there you also encounter that he says, you now must intervene yourself. I think that could also be done with anesthesia." (Interview AM7)
"Dus net als de zelfrijdende auto heb je natuurlijk dat hij zegt van joh, je moet nu zelf ingrijpen. Dat zou denk ik met anesthesie ook kunnen." (Interview AM7)

AM2 sees AI as something with self-learning ability, which applies to a very wide area. Something that eventually gets its own thoughts, by way of a lot of input. And the more input the better, the more it learns and the more it can make good decisions by itself. For the OR specifically, AM2 thinks that if the monitoring of a huge amount of patients could be registered, this can be used by AI to think ahead and anticipate. And with that, predictions can be made for the vital values of the patient. For example, through accuracy predictions in the form of a certain chance that something will happen, or that certain values are coupled to the amount of pain and sleep medication that are needed. So, preventive actions could be taken, or medication waste could be countered (Interview AM2).

Also AM0 expects that the form of AI in monitoring will be that he is alerted by AI (Interview AM0). He thinks that the prediction of risk factors is the direction that we should go for. For example, the prediction, on the basis of the type of surgery, medical history of the patient, BMI, etcetera, that for this patient the chances are high that the blood pressure will drop in 5 minutes (Interview AM0). AM1 thinks that predictions made by AI, for example by improving the BIS-monitor in predicting when the patient will awake, would not necessarily yield a lot of profit for the anesthesia assistant himself, but an enormous amount for the process. And that that would benefit the patient safety (Interview AM1).

AM2 and AM7 especially think that AI could be of value in the calculation of the amount of medication that must be administered to the patient, as this is nowadays mostly done with calculation based standard doses times the weight of the patient (Interview AM2; Interview AM7). Incorporation of the age, functioning of the liver and kidneys, and other factors, could lead to a better prediction of the amount of medication and the timing of when it should be given to the patient (Interview AM7). AM7 expects that predictions of AI would really help, such as predicting hypotension events or that fluids must be administered, based on hart rate, blood pressure, and the amount of incoming and outgoing fluids (Interview AM7).

Another expectation, of AM1, is on the automation of processes. He thinks that standalone equipment might be talking together, meaning that he will be only there to check the equipment. According to him, the breathing tube will be introduced into the patient by an automated device, and the ventilator will soon be so smart that it can measure the amount of pressure needed to get the volume into the lungs based on the compliance of the lungs. The latter is something that already happens, but will become much smarter. Maybe real-time sensors could be present in the blood and adjust the composition of the blood based on these measurements, or an ingested pill could measure vital values for the monitoring (Interview AM1).

AM2 expects that it will take a while before AI is implemented in healthcare due to the large amount of rules, cares about patient safety, and other barriers. He wonders whether he is going to experience the introduction of AI in the OR himself during his career (Interview AM2). There are also doubts about the costs of the use of AI at the OR. AM3 thinks that although AI is a very nice system, it will cost so much money that AI-assisted monitoring will never really be implemented at the OR (Interview AM3). Also because of the amount that data that is needed and must be imported and updated, he wonders whether it would really work (Interview AM3). Also AM7 does not know how soon the introduction of AI in the AI will take place. He wonders whether it will be 10, 15 or 20 years from now. It is hard to predict, as the electric cars were also suddenly booming in five years' time. His feeling is that it will still take a long time before it could be implemented (Interview AM7).

6.2. Anesthesia assistants' attitude towards AI-assisted monitoring

As explained in Chapter 2, the behavioural intention of AI-assisted monitoring by anesthesia assistants depends on their attitude towards AI-assisted monitoring, as well as their subjective norm and the perceived usefulness of AI. The attitude is influenced by the perceived ease of use and the perceived usefulness. The behavioural intention of anesthesia assistants cannot be measured due to fact that AI-assisted monitoring is not in use at this moment at the OR. For that reason, this section gives insight in the attitude of the interviewed anesthesia assistants towards AI-assisted monitoring, their perceived ease of use and perceived usefulness of AI-assisted monitoring, and their subjective norm. Also, the preferences and concerns that have come forward from the interviews are discussed.

6.2.1. General attitude towards AI-assisted monitoring

In general, the anesthesia assistants are quite positive towards AI-assisted monitoring, under the condition that it is in the form of AI giving an advice (Interview AM0; Interview AM1; Interview AM2; Interview AM4; Interview AM5; Interview AM6 Interview AM7). So, if AI would predict a hypotension event, or something similar, that is seen as valuable for their profession, as it allows you to anticipate on that event on beforehand (AM0, AM1, AM7). These predictions could also prevent that a patient will experience pain (Interview AM0). According to AM4, it will make you alert in a different way, which contributes to the monitoring task (Interview AM4). AM5 says that he would find it very useful if AI would provide suggestions or predicts risk factors, as a human can always miss something (Interview AM5). Likewise, AM6 sees it as an extension of your alarms, but the alarms at this moment will only go off if something already happened, he believes it would be amazing if the alarm would go off 10 minutes before something might happen (Interview AM6).

"That seems fantastic to me. Yes, and then you can still see and decide: I will do it or I will not. But then you are alert in a different way. So that seems great to me." (Interview AM4)

"Dat lijkt me fantastisch. Ja, en dan kun je altijd nog eens te kijken van: ik doe het wel of ik doe het niet. Maar dan ben je op een andere manier alert. Dus dat lijkt me geweldig." (Interview AM4)

According to AM7, anesthesia assistants must now make decisions based on their feeling and experience, and if a computer would give you advice on what to do but you can still make the decision yourself, that would make the profession easier (Interview AM7). As it will allow you test the advice against your own ideas, and that way help you to make a decision. It would give something to hold on to, which is helpful in the dynamic profession of anesthesia assistants (Interview AM7). Furthermore, it allows you to provide better care for the patient, as you can use better criteria to arrive at a good policy for the patient because you simply have data on which you can base your argument (Interview AM7).

AM3 is somewhat more negative towards AI-assisted monitoring. He says that he is alright with as long as you use it as a kind of advice. But that it should not be used to lead, because he is the one who takes control and makes decisions, not a computer (Interview AM3).

"If you are using it as some sort of advice, then it is fine. But it should not be leading. Because I am in charge, not a computer." (Interview AM3)
"Als je het gebruikt als een soort advies, dan is het prima. Maar het moet niet leidend zijn. Want ik bepaal de regie, en niet een computer." (Interview AM3)

The condition that AI can make suggestions, but one is still able to decide on what is going to happen is mentioned by almost all anesthesia assistants (Interview AM0; Interview AM1; Interview AM2; Interview AM3; Interview AM4; Interview AM5; Interview AM6). So, that you are able to think for yourself whether you will deviate from it or not, and that the computer will only coach you into a certain direction, but you still think and decide for yourself (Interview AM6). AI will not be always right, so an anesthesia assistant will have to dare to deviate from the advice of AI when needed (Interview AM6). A device that will predict what to do for you, evokes some fear at AM1 to lose interest in his profession (Interview AM1). They should be able to decide whether they inject certain medication right away or wait a minute (Interview AM5). Or if the computer suggests building up or reducing some of the medication, you should still be able to decide to not go along with the suggestion, for example based on the time that is left of the operation (Interview AM3). Using it as a guideline is fine, that could be of addition, but it must be up to the anesthesia assistants to decide on whether to follow up the suggestion (Interview AM3). The system should not go on tilt when the suggestion is not followed (Interview AM3).

"Taking those choices completely off your hands is not the solution. Giving good suggestions is." (Interview AM1)
"Het helemaal uit handen nemen van die keuzes is niet de oplossing. Het geven van goede suggesties wel." (Interview AM1)

AM0 thinks that AI that will make an anesthesia assistant aware of something will be embraced by many anesthesia assistants, as over the past ten years more and more equipment has been introduced at the OR and this is also valued by them (Interview AM0). Extra help in the form of extra parameters would be very nice and not considered as a threat (Interview AM0). But, as long as AI is a helping tool, and not taking over the full task (Interview AM0).

Another reason for anesthesia assistants to look positively towards AI-assisted monitoring, is that they think it will contribute to patient safety (Interview AM1; Interview AM2; Interview AM4; Interview AM6; Interview AM7) or the efficiency of the monitoring process (Interview AM1; Interview AM6). AM1 and AM6 think that predicting events by AI will improve the patient care by earlier identification of problems, which allows anesthesia assistants to anticipate better on the event (Interview AM1; Interview AM6). And it prevents you from overlooking things (Interview AM4). And everything that will make it better for a patient is seen as positive (Interview AM2). AM1 says that he thinks that AI at the OR will probably not generate a lot of profit to the anesthesia assistants themselves, but a lot for the process (Interview AM1). But if that means that patients are shorter in the hospital, or other benefits for the patient, he mentions that you are 'checkmate' by the scientific results of using certain device. Meaning that his potential thoughts on wanting to do the monitoring himself are inferior to the benefits of AI for the patient (Interview AM1). Making processes more efficiently is only a good thing, and he thinks that eventually other people will see that too (Interview AM1).

"But when you see the scientific results of using this device, yes, you're just checkmate." (Interview AM1)
"Maar als je ziet wat de wetenschappelijke uitkomsten zijn van het gebruik van dit apparaat, ja, dan sta je gewoon schaakmat." (Interview AM1)

According to AM2, AI-assisted monitoring might provide a more stable patient, meaning that continuous relaxation of the muscles of the patient might not be needed. And all medication that does not have to be administered to the patient is absolutely much better for the patient (Interview AM2).

AI-assisted monitoring might also contribute to reducing workload of anesthesia assistants, and eventually even might solve the shortage of personnel. AM4 mentions that a helping hand during the operation would be useful to reduce workload (Interview AM4). And AM0 and AM6 say that a computer that watches the monitor for you, will allow you to do other tasks (Interview AM0; Interview AM6). During the induction period most events happen, while this is also the busiest period for the anesthesia assistant (Interview AM0). So, AI that would signal or even predict a blood pressure drop or something similar, would help you to react in time to a certain event (Interview AM6).

On the topic of AI slowly taking over parts of the tasks of the anesthesia assistant, there is both resistance and cautious positivity among the anesthesia assistants.

AM0 cannot imagine AI to really take-over parts of the job. He even wonders what kind of society we would live in if we would take-over all anesthesia assistants by AI (Interview AM0). He really sees AI as a helping hand for the anesthesia assistant (Interview AM0). On the short term, AM1 sees more of an addition than a take-away of proceedings, as the addition of extra measured values. In the further future there might be a kind of tipping point, where certain actions of anesthesia assistants will be taken away (Interview AM1). AM7 does not think that AI would quickly take over the full profession of the anesthesia assistant, as for example the induction of the patient is too unpredictable. But perhaps in 20 years' time, he does not rule the option out (Interview AM7).

If AI-assisted monitoring would be of such high quality that it would allow an anesthesia assistant to take on a multiple room system like the anesthesiologist (see Chapter 4), also the shortage of personnel could be reduced (Interview AM6; Interview AM7). This means that AI would perform the monitoring and give an alarm in case of occurring events to the anesthesia assistant that is not present at the OR (Interview AM7). Especially if this would be in good collaboration with the surgeon, which could indicate the risky parts of the surgery, it could potentially be a good option according to AM6 to let AI monitor the patient and predict a change in blood pressure or other vital measurement on time so that the anesthesia assistant could be at the OR to administer medication (Interview AM6). According to AM6 and AM7, this will make the job less boring, especially in operations like certain brain tumor surgeries that take very long and not much is happening, or operations under local anesthesia (Interview AM6; Interview AM7). Doing nothing might sometimes feel as relaxed, but they are also quite exhausting, according to AM7 (Interview AM7). A multiple room system would also allow you to do other, nicer and less boring, activities (Interview AM6; Interview AM7). For example, by taking over tasks of anesthesiologists (Interview AM6). On the other hand, AM2 is worried that it would make it more boring for anesthesia assistants (Interview AM2). According to AM7, this form of AI-assisted monitoring would also be very useful for the current staffing-level (Interview AM7). Then the anesthesia assistant could still be present during the induction and the end phase in which the patient is woken up, and during complications, while for the standard procedures an AI auto-pilot could take over (Interview AM7). AM7 would find that awesome (Interview AM7). However, there would still be doubts by AM6 on this form of AI-assisted monitoring, as he mentions that thinking for yourself as anesthesia assistant and assessing the situation is still very important, as well as that it would take some charm from the profession (Interview AM6). But, if the patientcare would benefit from it he does not see so much of a problem (Interview AM6). AM1 thinks that eventually we will have to move to such a system, due to the tight labour market, as the personnel shortages will only increase (Interview AM1). But he only encourages it if the system would deliver a possibility to really cut back on personnel. It must really pay off to get his approval (Interview AM1).

"There are simply more interventions where we think…. Well. You know, we also do a lot of surgery here under local anesthesia. And we really do not have to be there. And that is locally anesthetised and then we are really there, just, to keep an eye on the patient. But if you then have an AI that signals a change in blood pressure or something in time, you are really there on time. That way I could have two rooms under my care." (Interview AM6)

"Er zijn wel gewoon meer ingrepen waarbij wij denken…. Nou ja. Weet je, we doen hier ook een heleboel ingrepen onder lokaal. En daar hoeven we ook echt niet bij te zijn. En dat wordt lokaal verdoofd en dan zitten wij er echt bij, gewoon, om de patiënt in de gaten te houden. Maar als je dan een AI hebt die op tijd een verandering in bloeddruk of iets signaleert dan ben je er echt wel op tijd. Zo zou ik best wel twee kamers onder mijn hoede kunnen hebben." (Interview AM6)

This form of AI-assisted monitoring is not seen positively by the other anesthesia assistants (Interview AM0; Interview AM2; Interview AM3; Interview AM4; Interview AM5). Mostly because they want to have the regie themselves (Interview AM2; Interview AM3; Interview AM5), as mentioned earlier, and they are worried that AI could make a mistake (Interview AM0; Interview AM4; Interview AM6). Some also think that other anesthesia assistants would not be open to that (Interview AM5; Interview AM7). AM5 compares the situation with how the anesthesiologist works right now, and that that form is fine only because there is still always someone next to the patient that can respond immediately if something goes wrong (Interview AM5). AM1 thinks that we should start with AI-assisted monitoring as a helping hand, where it offers suggestions to the anesthesia assistants. And that later on, there might be a step towards more automation, where the AI-assisted monitoring performs the monitoring task, but the anesthesia assistant must approve the decisions made by AI and intervene if they do not agree (Interview AM1).

While most anesthesia assistants have difficulties imagining that AI would take over parts of their job, AM1 and AM6 notice that 30 years ago they could not imagine things that we now consider quite normal

(Interview AM1; Interview AM6). As that all measurements are directly registered by the computer, and do not have to be written down by hand anymore (Interview AM6). This field will evolve along with this smart system of AI (Interview AM1). Meaning that the anesthesia assistant will also get different tasks, as for example more focus on patient comfort, or on the position during the operation. Things that are a bit more subordinate nowadays (Interview AM1).

AM1, AM5 and AM7 are convinced that innovation with AI is necessary, and that it is the future (Interview AM1; Interview AM5; Interview AM7). For example, due to the personnel shortages and tightness in the labour market that will only increase in the coming years (Interview AM1). Consequently, they think their own opinion is less important, as they feel that it is a matter of must (Interview AM1; Interview AM5).

6.2.2. Perceived usefulness and perceived ease of use

The perceived usefulness and perceived ease of use of AI-assisted monitoring impact the attitude of anesthesia assistants towards AI-assisted monitoring (see Chapter 2). These are therefore separately investigated.

The perceived usefulness of AI-assisted monitoring by the anesthesia assistants is seen positively by the anesthesia assistants. The perception is that using AI-assisted monitoring will enhance the monitoring performance (Interview AM2; Interview AM3; Interview AM4; Interview AM5). AM4 and AM7 mention that it will make it safer for the patient (Interview AM4; Interview AM7). AM6 and AM7 mention that it might not increase the effectivity of the monitoring, but it will benefit the patient, by for example preventing a low blood pressure (Interview AM6; Interview AM7). The low blood pressure might not be deadly for the patient, but it will do some harm to the patient (Interview AM6). So, AI-assisted monitoring will ensure a better anesthesia given by the anesthesia assistant, which is better for the patient (Interview AM6).

"So I think: in the end this would give a much better anesthesia and better anesthesia is by definition better for the patient." (Interview AM6)

"Dus ik denk: uiteindelijk zou dit wel een veel betere anesthesie geven en een betere anesthesie is per definitie beter voor de patiënt." (Interview AM6)

The perceived ease of use of AI-assisted monitoring, so whether using AI will take or take no effort and therefore whether the monitoring task will take more or less effort, is viewed more diverse by the anesthesia assistants. According to AM2, it depends on how you experience the effort of monitoring, as the monitoring will happen by itself (Interview AM2). He says that the actions you must perform, based on the values that come out of the monitoring, is what will take effort. Therefore, if AI-assisted monitoring could warn before the event occurs, which results in that you must give less medication as opposed to after an event took place, this would make the monitoring task take less effort with the help of AI-assisted monitoring (Interview AM2).

"That depends on what you find difficult in monitoring, because of course it happens by itself, the monitoring. It is often the actions based on what values come out and you must do something with. So I would say: yes, if indeed it is before it. If you are ahead of it, then you must give less than if it is too late, then you must give a lot again, so to speak." (Interview AM2)

"Dat ligt eraan wat je het monitoren aan moeite vindt, want het gebeurt natuurlijk zelf, het monitoren. Het zijn vaak de handelingen op basis van wat voor waardes eruit komen en waar je wat mee moet gaan doen. Dus ik zou zeggen: ja, als het inderdaad het voor is. Als je het voor bent, dan hoef je minder te geven dan als het te laat is dan moet je juist weer veel geven, om het zo maar te zeggen." (Interview AM2)

On the other hand, all new things take time to get used to, and will take energy, according to AM3 (Interview AM3). AM7 also thinks that for some anesthesia assistants it will get more difficult in the beginning, as you will receive more information (Interview AM7). But, AM3 thinks that later on it will go along with the rest, and does not take more or less effort (Interview AM3).

AM7 thinks that it might become easier because you do not have to pay attention all the time anymore, but it could also increase the amount of alarms in such way that it will take more effort (Interview AM7). Also AM4 thinks that it might become easier, because one might get lazier with the idea that AI will warn you if something happens (Interview AM4). However, he also mentions that the change from putting all vital values down on paper in the past to the automatic registration in the computer did also not result in getting lazy as anesthesia assistants, so he doubts whether that really will happen (Interview AM4).

In contrast, AM5 and AM6 think that it will not change anything, so it will not take more or less effort, as they will still keep an eye on all parameters themselves all the time and that will not change because AI might alert you and give suggestions (Interview AM5; Interview AM6). Especially, because you sometimes have

more information than AI, as AI might warn you that the blood pressure is about to drop but you know that the surgeon is about to start operating on the patient (Interview AM6). But it might give some more rest, and therefore might be a bit easier, according to AM6, as it will allow you to have some extra time to think and prepare medication and therefore prevents you from making mistakes (Interview AM6).

6.2.3. Subjective norm

The behavioural intention of AI-assisted monitoring by anesthesia assistants is influenced by their attitude towards AI-assisted monitoring, the perceived usefulness of AI-assisted monitoring, as well as their subjective norm (see Chapter 2). The subjective norm, or social pressure from colleagues and management that anesthesia assistants feel about whether or not to use AI, will impact some anesthesia assistants' acceptance of AI-assisted monitoring, but on others it will have no impact at all.

For AM7, his acceptance of AI-assisted monitoring does not depend on what his supervisor or friends think of AI (Interview AM7). Also for AM2 and AM4, it would not have any impact what their colleagues think of AI (Interview AM2; Interview AM4). AM4 says especially not if others are complaining about something new that is introduced, because he says that he is not sensitive to that (Interview AM4). However, for AM2 it would matter what the management and anesthesiologists think of it, as the introduction would be done via them, and the anesthesiologists have to work with it too (Interview AM2). Also for AM6, the opinion of the anesthesiologists does matter, as they are his boss at the OR, and if they think that AI-assisted monitoring is nonsense he would be less inclined to participate in it (Interview AM6). So, for him, the anesthesiologists must support AI-assisted monitoring for him to adopt AI. But they have to come up with good argumentation why they are against it (Interview AM6).

"Yes, well, then managers in the sense of: the anesthesiologists have to come along, they have to support it. … Yes, they are the boss. At the OR, the anesthesiologist is my boss. So if they say: yes, it is nonsense, because you know.. they must of course come up with a good story, but then you are less inclined to participate in it yourself." (Interview AM6)

"Ja, nou ja, dan leidinggevenden in de zin van: de anesthesiologen moeten wel mee, die moeten erachter staan. … Ja, die zijn de baas. Op OK is de anesthesioloog mijn baas. Dus als die zeggen: ja, het is onzin, want weet je.. ze moeten natuurlijk wel met een goed verhaal komen, maar dan ben je zelf toch minder geneigd om daar aan mee te doen." (Interview AM6)

6.2.4. Preferences (in AI-assisted monitoring)

Anesthesia assistants are quite positive towards the prediction of risk factors by AI (see Section 6.2.1). During the interviews, various preferences or other desires regarding AI-assisted monitoring were mentioned. Furthermore, specific devices that could use improvement by AI were indicated.

Firstly, anesthesia assistants would also value AI if it would remind or alert you of certain medication that the patient needs, based on the progress of the operation and patient data (Interview AM0; Interview AM4; Interview AM6; Interview AM7). Because the anesthesia assistant is sometimes so busy that it for example forgets to administer antibiotics to the patient (Interview AM0; Interview AM4; Interview AM6). And, for AM4 the biggest fear in his profession is to miss something or forget something important, as there might be a big risk connected to it. But the preference is that the alarm does not go off at the exact time of that the medication should be given, as one might be busy with another task and is therefore unable to immediately administer the medication to the patient (Interview AM4).

"Given the history of 100,000 people, so to speak, you have to act now. That can for example be very simple: antibiotics. Yes, it may well be that we forget that, because at that moment we did not make a note on a notepad – good old-fashioned - from: at 4 o'clock we need antibiotics again and then you are just busy at 4 o'clock, because there is a bleeding and... and you forget your antibiotics, which could increase your infection. Yeah, so it would be good if you got a pop-up saying, hey, you are already 10 minutes late on your antibiotics." (Interview AM4)

"Gezien de geschiedenis van 100.000 mensen, bij wijze van spreken, moet je nu wel iets gaan ondernemen. Dat is bijvoorbeeld heel simpel: antibiotica. Ja, het kan best zijn dat we dat vergeten, omdat we net even op dat moment niet een aantekening hebben gemaakt op een briefje - lekker ouderwets - van: om 4 uur moeten we weer antibiotica en dan ben je om 4 uur net druk, want het is een bloeding en.. en je vergeet je antibiotica, waardoor je infectie kan stijgen. Ja, dus het zou toch goed zijn als je een pop-up krijgt van: hé, je bent al 10 minuten over tijd met je antibiotica." (Interview AM4)

Secondly, in accordance with the expectations of AM2 and AM7 (see Section 6.1.2) their preference would be that AI would play a role in the calculation of the amount of medication the anesthesia assistants should administer to the patient, and the timing of it, by incorporating patient data and vital measurements

(Interview AM2; Interview AM7). AM7 would want AI to give a score, based on the combination of certain vital parameters such as heart rate and blood pressure with patient data and history, of for example the amount of pain a patient experiences. And that the scores are related to a certain advice on the administering of certain medication in a certain amount (Interview AM7).

Thirdly, also for other predictions, AM5 and AM7 would want AI to combine vital measurements and thus integrate multiple values into a prediction (Interview AM5; Interview AM7). Likewise, AM6 would want AI to incorporate information on the type of surgery in its predictions. That AI, for example, understands that when a laparoscopic operation is performed and the abdomen of the patient is inflated with carbon dioxide, the blood pressure will rise but will stabilise itself. So, then there should be no prediction that pain medication should be administered to the patient based on the increasing blood pressure (Interview AM6). Related is the wish by AM1, namely that AI could make predictions in when a patient will awake. If AI would couple measurements, such as the values of the BIS-monitor and infuse pumps, the process could be made more efficient for anesthesia assistants according to AM1 (Interview AM1). The most important devices that should work together according to AM1 are the infuse pumps, ventilation machine, Philips monitor, and registration in the computer. These devices are already next to each other, but there is no coupling between them yet. With that, also integrated alarms would become possible (Interview AM1). For these alarms, AM1 would want threshold values tuned on the patient data, as the values necessary for alarms are really dependent on the type of patient (Interview AM1).

Fourthly, AM0 mentions that not all vital measurements cannot be performed continuously. For example, the blood pressure measurement is often done only once per five minutes. He mentions that it could be beneficial if AI would be able to predict values of parameters that are not measured directly. Furthermore, AI could perhaps use the patient data or data of the used medication and infusion fluids to predict which vital measurements are the most important to be performed. Or that need extra attention by the anesthesia assistant (Interview AM0). The anesthesia assistant does not want 100 parameters, but wants to know on which parameters to focus, and get accurate values for those (Interview AM0).

One of the monitoring devices where anesthesia assistants see room for improvement is the BIS-monitor. This monitor measures the depth of the sedation at the patient (see Chapter 4). The BIS value is one of the three factors that is incorporated by the anesthesia assistant to decide whether a patient its level of consciousness is low enough and whether the patient has enough painkilling (Interview AM2). However, according to the anesthesia assistants the calculation of the BIS value is an inaccurate measurement (Interview AM2; Interview AM4; Interview AM6), as well as is 15 to 30 seconds behind in time (Interview AM0; Interview AM1; Interview AM2). This means that if the value becomes high, and thus the consciousness of the patient is increasing, it is already for 15 to 30 seconds that high (Interview AM0; Interview AM2; Interview AM5). Consequently, the BIS value is less of added value as it could be, according to AM5 (Interview AM5). AM6 mentions that the BIS-value sometimes is very low, while the patient is already awake, or the other way around with a sleeping patient with a very high BIS-value. For that reason, he says that he sometimes pulls the BIS-monitor out of the Philips monitor, because the numbers were so incorrect that it made him restless (Interview AM6).

> "Yes, it is often that the surgeon says: "I see the patient moving" and that I think: "Oh, I do not see it here yet" and only then it happens. 15 seconds does not sound like much, but... In the end, 15 seconds, that is quite a long time." (Interview AM2)
>
> "Ja, het is vaak wel dat de chirurg zegt: "ik zie de patiënt bewegen" en dat ik denk: "joh, ik zie het bij mij nog niet" en het dan pas gebeurt. 15 seconden klinkt weinig, maar... Uiteindelijk 15 seconden, dat is best wel lang ook weer." (Interview AM2)

Improvement in this monitor could lead to a more accurate value as well as a shorter delay to ensure that an acute value of a parameter does not come too late (Interview AM0; Interview AM2; Interview AM4; Interview AM5). As the BIS value is also influenced by the blood flow in the head, and a low blood pressure results in a low BIS-value it might be beneficial to incorporate the blood pressure measurement in the calculation of the BIS-value, according to AM6 (Interview AM6). Improvement in the BIS monitor could not only be beneficial to the anesthesia assistant but also for the surgeon, as the patient might be moving, as well as for the patient, as less medication to relax the muscles is needed and there is a smaller chance on awareness (Interview AM2).

Likewise, improvements could be made for the pulse oximeter, which is also behind in time (Interview AM6; Interview AM7). AM7 estimates that it is about a minute behind in time, which could lead to a blue patient due to a lack of oxygen before the anesthesia assistant can notice on the monitor that the saturation has dropped (Interview AM7).

"Yes, yes, absolutely, because sometimes you already have a very blue patient and only then do you see the saturation drop on the monitor." (Interview AM7)

"Ja, ja, zeker, want soms heb je al een hele blauwe patiënt en dan zie je daarna pas de saturatie dalen op de monitor." (Interview AM7)

Another device in which AM0, AM2 and AM6 would see benefits by incorporating AI in the machine, is the ventilation machine (Interview AM0; Interview AM2; Interview AM6). According to AM2, there is not always optimal ventilation of the patient due to a lack of knowledge (Interview AM2). Increasing the accuracy of the measurements could be beneficial according to AM6 (Interview AM6). By extension of the information of the machine by using AI with data of medical patient history and certain parameters, more accuracy could be gained (Interview AM0).

6.2.5. Concerns regarding AI-assisted monitoring

Next to the mentioned preferences, there are also some concerns among anesthesia assistants regarding AI-assisted monitoring. First of all, AM0 mentions that we must be careful not to try to improve things that cannot be improved. We must develop things that are of value. New developments should match the wishes of the OR staff, and it should be prevented that things are developed that are not more efficient or do not contribute anything for the OR staff (Interview AM0).

Besides, according to AM0, it is questionable whether running on autopilot by using AI-assisted monitoring is the safest way, as it increases the chances on losing sight of the patient. While each operation is the same, each patient itself is different in hypertension, renal failure, etcetera, so every patient needs attention (Interview AM0). Another point made by AM1, is the pitfall that if everything is predicted and anesthesia assistants are only present to check and not perform the thinking, more and more specialisation occurs, which is not always a good thing (Interview AM1). Furthermore, it might lead to laziness among anesthesia assistants according to AM4. As they might think that the system will warn in case of deviations and therefore do not have to constantly look at the monitoring anymore (Interview AM4). And it might lead to the anesthesia assistant to perform less self-thinking and reasoning (Interview AM6). This is especially worrying, as AI might not always be right. It will probably be right in nine out of ten cases, but there is always that one patient that is deviating from the expectations. The danger is that the anesthesia assistant will automatically follow the direction that AI sends you (Interview AM6). The anesthesia assistants must then signal the deviating situation by themselves and dare to deviate from the predictions made by AI (Interview AM6). AM0 mentions as well that it is an often-made statement by OR staff that in principle you could teach a monkey to stand at an OR, but unexpected things can always happen outside of the standards, and outside of the protocols. This means that an anesthesia assistant must be able to remain calm, know how to respond and behave, and decide what the following steps will be. These are things you cannot teach a monkey, and neither AI (Interview AM0).

Building on that, the anesthesia assistant monitors the patient based on their experience. If someone does not have that experience yet and is trained in patient monitoring while AI-assisted monitoring is on the side, the AI is very good in helping you. But the question and concern are, if AI is always predicting an event ahead of you will you then still be able to really learn how to monitor the patient? (Interview AM6).

In contrast, AM2 and AM7 mention that you have to self-think and monitor as anesthesia assistant whatsoever (Interview AM2; Interview AM7). As also without AI, the measurements can deviate due to confounding factors as a surgeon that shakes the patient or a blood pressure cuff that has fallen off. For that reason, you can never only rely on what the computer says (Interview AM7). AM7 even thinks that it will stimulate the self-thinking of an anesthesia assistant. As, instead of just doing something based on your ideas and experience, you will get some advice on which you can test your ideas. It will enable you to reason why AI makes its predictions (Interview AM7).

An often-mentioned concern of AI-assisted monitoring among the anesthesia assistants is the fact that every patient is different, and that AI would not be able to see, hear, and feel the patient (Interview AM1; Interview AM3; Interview AM4; Interview AM5; Interview AM6). When for example the blood pressure is suddenly changing, extra information is gained by the anesthesia assistant by amongst others looking whether the patient is sweating, has enlarged pupils, or is breathing along (Interview AM1). And that is also patient dependent, as the degree of sweating differs per person. It is therefore based on interpretation and is thus not so easily quantifiable (Interview AM1). Anesthesia assistants use the monitoring as a guideline but looking at the patient is even more important, which would not be incorporated in the predictions by AI (Interview AM3). AM4 also mentions that the clinical view is very important, as someone can be sweating, indicating that something is wrong, when all vital values are normal (Interview AM4).

"We look at the patient, how he is doing, and not at monitoring. Monitoring is nice, a nice guideline. But the patient says it all." (Interview AM3)

"We kijken naar de patiënt, hoe die het doet en niet naar monitoring. Monitoring is leuk, een leuke richtlijn. Maar de patiënt is alleszeggend." (Interview AM3)

"You have to look, you have to feel, is someone sweating? If someone is sweating, yes, then something is wrong, something is not right, because of stress, yes, so you really must look at the patient himself. Yes, sometimes everything is fine and yet someone is sweating. I think, yes then you must find out what the origin is. I do not know if a robot can do that." (Interview AM4)

"Je moet kijken, je moet voelen, zit iemand te zweten? Als iemand zweet, ja, dan is er iets mis, dan is er iets niet goed, door stress, ja, dus je moet wel echt goed naar de patiënt zelf kijken. Ja, soms is álles in orde en toch zit iemand te zweten. Ik denk, ja dan moet je toch achterhalen waar dat vandaan komt. Ik weet niet of een robot dat kan." (Interview AM4)

It would also be important that AI does not respond to the deviation of only a single vital parameter. As anesthesia assistants incorporate different vital parameters into the decision whether to take action (Interview AM1; Interview AM2).

Furthermore, as every patient and every surgery is different, it might be the case that something deviant happens that the algorithm is not trained on (Interview AM0; Interview AM2; Interview AM6; Interview AM7). AM0 mentions that the most dangerous patients are sporty men in their seventies who appear to be in perfect health. They do not take any medication or see a doctor. However, at the OR the blood pressure can suddenly collapse, arrhythmias occur, etcetera (Interview AM0). And every patient responds different to the anesthesia, even with comparable patient data. This also means that someone who seems non-complex in advance might suddenly become complex during the surgery (Interview AM2). With the same operation and treatment, one might keep breathing while the other one will stop breathing (Interview AM2). So, if you determine the algorithm based on medical information, then not everything about the patient is always known. This remains a danger when devising a system for patient monitoring, as there can always be unknown things in patients (Interview AM0).

Another point of attention is that the model of AI should be continuously re-trained based on new data to adapt to changes in the data. The concern of AM3 is that the system will not be updated very well. If the system for example would incorporate data of the proceedings of the surgeon in the operation, and the surgeon will become faster over time, the system may still be set on the slower operating time of that surgeon (Interview AM3).

If AI-assisted monitoring would take the form where the anesthesia assistant will be responsible for multiple rooms, and monitors on a distance, the biggest concern of AM5 and AM6 would be that changes in the situation of the patient appear very quickly. If the anesthesia assistant would be on a distance, and a major bleeding would occur, you will have to be next to the patient immediately otherwise you are too late (Interview AM5; Interview AM6). And if a patient would suddenly wake up, he will make slapping movements, turns infusions off and pulls breathing tubes out. The AI system could not prevent this from happening by only responding with giving sleep medication to the patient at the moment of the event (Interview AM5).

Furthermore, the concern would then be who will bear the responsibility if something goes wrong with the patient (Interview AM3). Moreover, if the future would comprise a fully automated OR, the humanity and thus warmth would completely disappear according to AM0. It would become a sort of factory around the patient (Interview AM0). This worries AM0, as a person that reassures patients in the OR is better than a robot. Furthermore, if the amount of personnel would decrease, it would make the profession of anesthesia assistants lonely (Interview AM0).

"Because if something changes in the situation of the patient, it changes very quickly. So, if you have a bleeding, or a patient suddenly sits up. Then you must stand next to it. Then a pump can imagine: well, the patient suddenly sits straight up, so I have to give 20 ml of a sedative and then the patient will go back to sleep. But of course, it does not work that way. The patient does when he wakes up, then he acts like this (makes a banging movement), he turns off the infuse, he pulls the breathing tube out, so I feel like I must be standing next to him." (Interview AM5)

"Omdat als er iets verandert in de situatie van de patiënt, dat het heel snel verandert. Dus als je een bloeding krijgt of een patiënt zit ineens rechtop. Dan moet je ernaast staan. Dan kan een pomp bedenken van: nou, de patiënt gaat ineens zitten, dus ik moet 20 ml slaapmiddel geven en dan gaat de patiënt wel weer slapen. Maar zo werkt het natuurlijk niet. De patiënt doet als die wakker wordt, dan doet ie zo (maakt slaande beweging om zich heen), die doet het infuus uit, die trekt de beademingsbuis eruit, dus voor mijn gevoel moet ik ernaast staan." (Interview AM5)

Finally, AM0 mentions the concern of losing motivation in the profession. There must be a balance between efficiency and motivation of personnel, otherwise ultimately no personnel will be left (Interview AM0).

6.3. Reflection on the results on perception and attitude

From the investigation of the perception of the anesthesia assistants, comprising knowledge, interest, and expectations on AI-assisted monitoring, it appears that their knowledge on the possibilities in AI-assisted monitoring is very limited. For that reason, also their expectations are limited. Despite the limited knowledge, there is interest on the possibilities of AI in their profession.

Their attitude towards AI-assisted monitoring that makes predictions and gives suggestions, after which the anesthesia assistant can make the decisions on what to do, is mostly positive. Amongst others, because it might contribute to patient safety and efficiency of the monitoring task, one gains more input to base decisions on, and potential reduce of workload. Also, AI that will alert you to for instance administer medication, helps in the calculation of medication amounts, and integrates multiple vital parameters and information of the surgery into its' predictions, is valued positively. A more automated form of AI-assisted monitoring is perceived mostly negative. Only two anesthesia assistants really see a positive side to the use of a more automated form of AI-assisted monitoring, as it would make their job less boring, and it may enable them to take on other tasks. Furthermore, the perceived usefulness of AI-assisted monitoring is valued positively, while the perceived ease of use is valued diversely. The impact of the subjective norm on their behavioural intention to use AI-assisted monitoring differs strongly per anesthesia assistant. Some concern on the use of AI-assisted monitoring is the chance of losing interest or ability to think and reason for themselves, causing the loss of sight on the patient. This is especially a worry as every patient is different, and might present differently than expected, on which AI may not be able to react properly, as well as that AI can make mistakes. Other concerns are the confusing impacts on the vital parameters by factors of the OR environment, that AI may not be able to handle, and the lack of incorporation of the clinical view on the patient by AI. For a more automated form of AI-assisted monitoring, also the concerns of sudden changes in the situation of the patient on which AI cannot respond in time, and the loss of humanity and warmth at the OR, are mentioned. Finally, these anesthesia assistants see possibilities in improving devices like the BIS-monitor, pulse oximeter, and ventilation machines by AI.

7. Results: Motivation of anesthesia assistants in their monitoring task

This chapter contains the results of the semi-structured interviews with the anesthesia assistants regarding the questions on motivation and the impact of AI on motivation (see the Operationalisation table in Appendix A). The focus of this chapter lies on the fourth sub-question of "How could the use of the AI possibilities affect the anesthesia assistants' motivation in their task of patient monitoring?". To research the motivation of anesthesia assistants for the task of patient monitoring, first the self-identified features that are important for their motivation were investigated, see Section 7.1. Subsequently, the motivational theory model for the motivation of anesthesia assistants in their patient monitoring task, as described in Section 2.3, was used to explore the importance of the motivational factors for the motivation of anesthesia assistants in their task of patient monitoring. The motivational factors of autonomy, relatedness, competence, self-efficacy, and self-actualisation were looked into. So, in Section 7.2, the degree of importance of the motivational factors, as described by the anesthesia assistants, is discussed in detail, as well as their explanations why these may or may be not important. In Section 7.3, the ranking of these motivational factors in importance by anesthesia assistants is described. Subsequently, in Section 7.4, the identified relations between the motivational factors by the anesthesia assistants is elaborated upon. The possible influence of the use of AI-assisted monitoring on these motivational factors, as depictured by the anesthesia assistants, is worked out in Section 7.5. Finally, in Section 7.6, a reflection on the results on motivation is given.

Although among the interviewed anesthesia assistants were both men and women, all anesthesia assistants are addressed masculine in this chapter to ensure confidentiality. Additionally, all anesthesia assistants are referred to as a number from zero to seven: AM0 up to AM7.

7.1. General motivation

To research the motivation of anesthesia assistants for the task of patient monitoring, in the first place the self-identified features that are important for their motivation were investigated.

AM1 is motivated to continuously follow and read the monitor, as he does not want the patient to awake when that should not happen (Interview AM1). Likewise, AM4 sees monitoring as an essential part of the job, and if you do not do that right that will be dangerous. That is why he is always automatically enormously motivated to watch the monitor (Interview AM4). AM1s motivation is to do his job as good as possible. Providing the best possible patient care by generating the most optimal conditions for the surgeon to operate. Thus, make the patient sleep as good as possible with as little hemodynamical deviations or changes as possible (Interview AM1). The surgeon is not able to perform the operation without the patient being well anesthetised, so the surgeon is AM1s extrinsic motivational factor. But the patient is in the end the ultimate extrinsic motivational factor for who he is doing his job (Interview AM1). AM4 also sees the patient as an extrinsic motivational factor, as he feels connected to the patient (Interview AM4). Taking good care of the patient is also the main motivation of AM5 (Interview AM5). AM7 states that the monitor in itself is not motivating, but that he just wants to provide good care for the patient and the monitor is a helping tool in that (Interview AM7).

> "So the motivation is that I want to provide the best possible patient care and I do that by generating the most optimal conditions for the surgeon to operate." (Interview AM1)
>
> "Dus de motivatie is dat ik een zo goed mogelijke patiëntenzorg wil leveren en dat doe ik door de meest optimale condities te genereren voor de chirurg om te opereren." (Interview AM1)

AM6 mentions that what he likes in monitoring, is the fact that never only one parameter changes in the monitoring values. If something changes, everything changes. On the monitor you are able to see that everything in the human body is related. For example, if the blood pressure drops, the heartbeat will increase. And, if there is a huge blood loss, there will be less pulse pressure, the saturation curve will become flatter, and the carbon dioxide will decrease. And that will also make you analyse what is causing the change in a parameter, or make you wonder whether the measured value is indeed correct (Interview AM6). Likewise, AM7 likes the fact that they are being trendwatchers. If the heart frequency changes for a couple beats, then they can intervene by for example giving some pain medication. Resulting in the frequency going back to normal again, which motivates him, as you get conformation that you have estimated the situation well (Interview AM7).

The social part of the job, as well as the technical procedures are mentioned as being satisfying. That you are able to comfort a patient, and take care of the patient, gives the most appreciation in your profession,

according to AM0 (Interview AM0). AM0 and AM3 mention that you can work with many different patients, and perform different operations, which makes the job fun (Interview AM0; Interview AM3). The medical technical procedures of injecting an intravenous line or inserting a breathing tube are the proceedings that make the job nice for AM1 (Interview AM1). AM2 also likes his profession mostly because of the many proceedings they may and must perform, in contrast to anesthesia assistant professionals in other countries (Interview AM2). Likewise, AM6 likes the fact that you have your own spot where you are working, and that you may perform a lot of actions by yourself (Interview AM6).

Additionally, the point is mentioned that they seek tension in their job (Interview AM0; Interview AM2; Interview AM6). AM2 prefers to be active during an operation. Operations where you sit all day, where the patient is as stable as they can be and nothing happens, are not interesting to AM2 as it just comprises static waiting until the operation is finished (Interview AM2). Although he also mentions that contrastingly, there are many of his colleagues that would enjoy these sorts of operations (Interview AM2). AM6 mentions that he likes the unexpected, for example an emergency surgery of a trauma patient which can be a patient in terrible conditions. The worse it is for the patient, the more fun it becomes for the anesthesia assistants, according to AM6 (Interview AM6).

7.2. Motivational factors of influence on task-specific motivation of anesthesia assistants

The motivational theory model for the motivation of anesthesia assistants in their patient monitoring task, as described in Section 2.3, comprises the motivational factors of autonomy, relatedness, competence, self-efficacy, and self-actualisation. Autonomy may comprise being able to make your own decisions and having input and responsibilities, and relatedness the feeling connected with colleagues as well as the task itself. Competence comprises feeling competent, where one feels that they have certain competencies to meet the demands and responsibilities of the monitoring task. Self-efficacy means the perception, or judgement and own confidence, that your own capabilities are enough to successfully execute the monitoring task at the desired level. Self-actualisation refers to the development of your own talents and potential by being able to learn new things and learn things from others.

All these motivational factors are found important by all the anesthesia assistants for their motivation in patient monitoring (Interview AM0; Interview AM1; Interview AM2; Interview AM3; Interview AM4; Interview AM5; Interview AM6; Interview AM7). According to AM0, a combination of all these motivational factors is what is important for his motivation (Interview AM0). For AM3, all these motivational factors together form the whole picture of what you do in your work (Interview AM3). AM1 mentions that all these motivational factors are important for his intrinsic motivation, and reasons for him to go to his work and enjoy his work (Interview AM1). AM4 also says that these factors are all really important for motivation in patient monitoring (Interview AM4).

"Yes! That completes the whole picture in the work thing that you are doing now, actually." (Interview AM3)
"Ja! Dat maakt het hele plaatje compleet in het werkgebeuren wat je nu doet, eigenlijk." (Interview AM3)

Autonomy

For AM2, AM5, and AM6 autonomy is very important for their motivation (Interview AM2; Interview AM5; Interview AM6). It enables you to be in charge (Interview AM5). Being able to perform tasks by yourself, having responsibilities, and your individual working space is even the reason why AM2 and AM4 have chosen this profession (Interview AM2; Interview AM4). The anesthesiologist is mostly outside of the OR, meaning that the anesthesia assistant should make decisions by himself, which makes the job the most enjoyable, according to AM2 (Interview AM2). AM4 also says that autonomy is the thing that makes the profession so enjoyable (Interview AM4).

"The anesthesiologist is always outside the OR, for the biggest part. So, then I have to make my own decisions. And that is what makes it fun, because with the knowledge you have you might make 10 different decisions for 10 different people. So, for me that is very important." (Interview AM2)
"De anesthesioloog is altijd buiten de OK, grotendeels. Dus dan moet ik ook mijn eigen beslissingen nemen. En dat maakt het juist leuk, want met de kennis die je hebt zal je bij 10 verschillende mensen misschien 10 verschillende beslissingen maken. Dus voor mij is dat heel belangrijk." (Interview AM2)

Autonomy is also important to AM0, AM3, and AM7, as they like it to be able to do a lot by themselves (Interview AM0; Interview AM3; Interview AM7). And AM7 likes the responsibilities they get in their profession, and that that is important for his motivation (Interview AM7). Especially, that the anesthesiologist gives the responsibility by leaving the anesthesia assistant alone at the OR by saying that one can call for help in case one needs that (Interview AM4; Interview AM7). AM0, AM1, AM4, and AM7 find it important to make choices by themselves, for example about which anesthesia one is going to administer or whether you accept or disregard an advice (Interview AM0; Interview AM1; Interview AM4; Interview AM7). AM0 emphasises that he always makes those decisions with the patient in mind. He likes the autonomy as it enables you to think about it yourself, as this also makes you proud. For example, if a patient did not have any pain during a major operation, this appreciation and pride are what makes the work fun (Interview AM0).

"Autonomy. Well, that is the fun part. That is what makes our profession so much fun, that you can make your own choices. At least, a lot of choices. And if you do not know it anymore, you always have the anesthesiologist in the background, or the AIOS." (Interview AM4)

"Autonomie. Nou, dit is juist 't leuke. Dat maakt ons vak juist zo ontzettend leuk, dat je zelf je keuzes kunt maken. Tenminste: heel veel keuzes. En als je het niet meer weet, heb je natuurlijk altijd de anesthesist op de achtergrond of de AIOS." (Interview AM4)

Competence

AM4, AM5, AM6 and AM7 find the development of certain competencies and feeling competent very important for their motivation, and AM3 thinks that feeling competent is important (Interview AM3; Interview AM4; Interview AM5; Interview AM6; Interview AM7). Then you have the feeling that you have everything under control, as you know and understand what is happening, and that is important for your motivation (Interview AM6). AM4 mentions that having developed competencies is the basis to be able to get autonomy and is therefore important for motivation (Interview AM4). Being able to feel competent, by trusting on your knowledge and the parameters you have is important according to AM7, as you are often unable to see the patient (Interview AM7).

"Yes, it's very important. That you have the feeling that you have it under control, that you know what is happening and you understand what is happening." (Interview AM6)

"Ja, is heel belangrijk. Dat je het gevoel hebt dat je het onder controle hebt, dat je weet wat er gebeurt en snapt wat er gebeurt." (Interview AM6)

Some competencies that are important at the OR, according to AM0, are clinical reasoning, collaboration, taking initiative, and responsibility, which means that one can analyse independently as well as solve problems (Interview AM0). AM2 thinks that having developed competencies is important to motivation, but not incredibly important. He thinks that everyone must have competencies, as it is part of their job, but there is always an anesthesiologist that you are able to call in case of doubts. Furthermore, feeling competent also depends on the patient and patient case (Interview AM2).

"I think everyone should have it, of course, because it is our job, but of course some feel more comfortable with some patient or less comfortable, depending on the case of the patient, but ultimately everyone can do it, so I would say: important, but not super, super important. Because you are also with an anesthesiologist, you can always call someone, in case of doubts and such, and there is often room for that too." (Interview AM2)

"Ik denk dat iedereen dat wel moet hebben natuurlijk, want het is onze baan, maar de ene voelt zich natuurlijk per patiënt wel fijner bij of minder fijn, afhankelijk van de casus van de patiënt, maar uiteindelijk kan iedereen het, dus ik zou zeggen: belangrijk, maar niet super, super belangrijk. Want je bent ook met een anesthesioloog, je kunt altijd iemand bellen, bij twijfels en dergelijke en daar is vaak ook ruimte voor." (Interview AM2)

Relatedness

Relatedness is important to AM0 and AM6, as the team feeling plays a central role in the job (Interview AM0; Interview AM6). The patient care is ensured by the whole team, according to AM0, AM4, and AM7 (Interview AM0; Interview AM4; Interview AM7). AM0 likes it that if you have had a busy day in which you have taken good actions or anticipated well on a certain event, that you will hear from time to time from the rest of the OR team that they had a great time working with you (Interview AM0). On the other hand, the collaboration is mainly with the anesthesiologist who is not there all the time. So, as anesthesia assistant you also work independently a lot of the time, which is sometimes also what you prefer according to AM0. Then you do not search for that relatedness. You are able to put the sterile drapes up, and work on your own while looking at your parameters, with no one disturbing you. This is in contrast with for example the OR assistants, as these constantly must collaborate (Interview AM0). AM4 even mentions that the relatedness with the patient is found more important for his motivation than relatedness with his team (Interview AM4).

AM1 mentions that the team is what makes his job enjoyable. The most important things in his job are the fun, the atmosphere, the intense casuistry, and the gallows humour (Interview AM1). He sketches the contrast of reanimating a child in the morning and joking around in the coffee room in the afternoon with his colleagues. This is especially important as you really have to trust each other in this working environment (Interview AM1). AM3 also says that having a nice team around you is important for your motivation, as relatedness with the team allows you to make things discussible (Interview AM3). Sharing unpleasant experiences with colleagues is very important in order to avoid people from collapsing (Interview AM4).

"But what makes our work the most fun is just the team. The fun, the atmosphere, the intense casuistry and then the gallows humour with everyone. That is the most important thing. You know: in a manner of speaking am I reanimating a child this morning, and this afternoon we are joking around in the coffee room, and that is because I just have a really good time with my colleagues." (Interview AM1)

"Maar wat ons werk het leukste maakt is gewoon het team. De lol, de sfeer, de heftige casuïstiek en daarna met zijn allen galgenhumor. Dat is het belangrijkste. Weet je: bij wijze van spreken sta ik vanochtend een kindje te reanimeren en vanmiddag zitten we te geinen in de koffiekamer en dat is omdat ik het gewoon heel goed heb met mijn collega's." (Interview AM1)

Relatedness is also considered very important for motivation by AM2, AM5, and AM7, both with the team as well as with the task (Interview AM2; Interview AM5; Interview AM7). The team ensures that the day flows smoothly, according to AM2. He also feels relatedness to the monitoring task, as he thinks that less relatedness to the task would entail that he would become laxer. And laxity could lead to making mistakes. That is why relatedness with the task is important to him (Interview AM2). AM6 also mentions that responsibility for the monitoring of the patient results in relatedness with the monitoring task (Interview AM6). AM6 says that even during the monitoring task, having a nice team that runs well together will increase your motivation, as monitoring is a big part of the profession (Interview AM6). Involving the rest of the team, as for example the surgeon, in the monitoring task is something that is tried by AM7, as that motivates him. AM7 is motivated when a surgeon says that he could hear that the blood pressure or saturation was dropping and asks whether he can do something to solve this (Interview AM7).

"And connectedness then with team and colleagues. Yes, I also find that very important. That is sometimes difficult in our profession, but it is extra pleasant if you have a good team, that you then bring to a successful end together." (Interview AM7)

"En verbondenheid dan met team en collega's. Ja, dat vind ik ook heel belangrijk. Dat is in ons vak soms wel moeilijk, maar het is dan wel extra gezellig als je een goed team hebt dat je dan samen tot een goed einde bracht." (Interview AM7)

Self-efficacy

Self-efficacy is considered very important for motivation by AM5 and AM6, while self-efficacy is considered important for motivation by AM2, but not very important (Interview AM2; Interview AM5; Interview AM6). According to AM6, you cannot perform the actions if you do not have self-efficacy, and if you are very insecure your profession will not be fun either (Interview AM6). AM2 mentions that there will always be patient cases that you have never seen before, or you must perform very quickly, that will make anyone doubt about themselves. However, he thinks that in the back of your head you will always know that you are able to do it. As you often are able to make decisions based on the knowledge you already have, even if it may be a completely new situation, it will almost always work out well (Interview AM2). AM7 also mentions that one must trust their own knowledge and be able to actualise that to the current situation (Interview AM7).

"Very important, otherwise you cannot do it. A bit of self-assurance, that is very good. ... No, but then your work will not be any fun either. Because if you are very insecure, then no...." (Interview AM6)

"Heel belangrijk, anders kan je het niet. Een beetje zelfverzekerdheid, dat is heel goed. ... Nee, maar dan wordt je werk ook niet leuk. Want als je heel onzeker bent, dan nee...." (Interview AM6)

AM3 mentions that self-efficacy is important for motivation, as it will give you confidence and you will be able to handle your work better (Interview AM3). AM4 and AM7 also think that it is necessary to have self-efficacy to perform your job (Interview AM4; Interview AM7).

For the motivational factor of self-efficacy, it was investigated whether the four variables of verbal persuasion, performance accomplishment, vicarious experiences, and physiological arousal, are of impact on the self-efficacy of the anesthesia assistants. Verbal persuasion comprises the encouragement by colleagues and getting their positive feedback, performance accomplishment the successful performing of actions in the monitoring task while solving potential issues, vicarious experiences the observing of other people coping with

a task, and physiological arousal the state of high alertness, meaning the feeling of tension and increase in blood pressure and heart rate.

Verbal persuasion

AM4 and AM7 are convinced that verbal persuasion, being encouraged by colleagues and getting their positive feedback, contributes to self-efficacy, as they experience it as very nice to be encouraged by colleagues (Interview AM4; Interview AM7). AM5 also thinks that it is quite important for self-efficacy (Interview AM5).

AM2 mentions that he finds verbal persuasion important for his self-efficacy, but that it does not happen that often in this profession. If a surgeon or anesthesiologist is happy with your performance and mentions that, it increases your self-efficacy, as it is not that common and for that reason you realise that you really did a good job (Interview AM2). AM6 also mentions that verbal persuasion is nice, but that it happens less frequent in this profession and because of that you know that as long as you do not hear anything it will be all right (Interview AM6). Likewise, AM1 thinks that if he gets admiration from many people that he has done a good job that will contribute to his self-efficacy, but that it does not work that way in this world of the OR. Getting a comment 'good job' by an anesthesiologist or from someone of the management is often the maximum that is achievable. Hence, AM1 thinks that it will not increase the competence nor the self-efficacy (Interview AM1).

"I notice that among all my colleagues that it makes them feel really good and that makes you think, wow, I think I did really well. Because something has been said about it at all, so as soon as something is said about it, it is taken seriously." (Interview AM2).

"Ik merk het bij al mijn collega's dat het echt goed doet en dat je daardoor denkt, van wow, volgens mij heb ik het echt goed gedaan. Want er is überhaupt wat van gezegd, dus zodra er wel wat van gezegd wordt dan wordt het wel serieus opgenomen." (Interview AM2).

AM3 mentions that the effect of verbal persuasion on your self-efficacy depends on many factors, such as how you were raised as a child, your age, and how you live your life. He says that he was raised with the idea that no news is good news. Hence, verbal persuasion is less of importance for his self-efficacy (Interview AM3).

Performance accomplishment

Being able to perform tasks successfully is important for the self-efficacy according to AM1, AM3, AM5, AM6 and AM7 (Interview AM1; Interview AM3; Interview AM5; Interview AM6; Interview AM7). For example, being able to prepare a difficult medication that is almost never used, as you exactly know how to make that, gives AM1 satisfaction (Interview AM1). The more things going successfully, the more you gain confidence in your capabilities (Interview AM3). AM7 mentions that the injection of an infusion still remains fun if you are able to succeed in that task, he thinks that that will never get boring (Interview AM7).

"Yes, of course. When things go well, the better... more you think: "Yes. Fixed." (Interview AM3)

"Ja, natuurlijk. Wanneer dingen goed gaan, hoe beter.. meer je denkt van: "Yes. Gefixt." (Interview AM3)

For AM4 this is a bit more nuanced, as he says that performance accomplishment increases the self-efficacy, but you should prevent to become dejected if it does not work out once, as it is also part of the deal that you sometimes do not succeed. Even then, you will have to believe in your capabilities (Interview AM4).

Successfully performing tasks increase the self-efficacy of AM2 only a little. He thinks that if he tries something that coincidently works out well, that will make him happy, but will not result in him thinking that he has done it extremely well (Interview AM2).

"Also nice. Yes, but then you should not get depressed if it does not work out once. Yes, that is also part of it: yes, it does not always go well of course. Sticking an infusion or something, or doing something else. But then you just have to believe in yourself again and think: yes, of course. And that does not go away anymore either." (Interview AM4)

"Ook leuk. Ja, maar dan moet je niet terneergeslagen worden als het een keer niet lukt. Ja, dat hoort er ook bij van: ja, het gaat niet altijd natuurlijk goed. Een infuus prikken of zo, of iets anders doen. Maar dan moet je gewoon weer in jezelf geloven en denken: ja, natuurlijk. En dat gaat ook niet meer weg hoor." (Interview AM4)

Vicarious experiences

Observing other people coping with a task does not affect the self-efficacy of AM3, AM5, and AM7 (Interview AM3; Interview AM5; Interview AM7). AM1 mentions that he does not get so much satisfaction from just seeing someone else performing a task (Interview AM1). But, seeing someone bumble in a task, gives AM1 confidence in his capabilities (Interview AM1). Then the condition for self-efficacy is that you are better in that task than the other person. Yet, if he sees his colleagues solve a difficult patient case, that also makes him very proud (Interview AM1). Furthermore, he does get satisfaction from teaching new colleagues the profession, or

from explaining an anesthesiologist, that is above him in the hierarchy, how something works (Interview AM1). In contrast, AM5 would want to help someone else in a task but not because it would make him feel better as the other person, as he does not find that important at all. It would give him a good feeling to be able to help someone else, but not in the sense of he cannot do it and I can do it better (Interview AM5). AM7 also says that seeing someone struggle does not increase his self-efficacy (Interview AM7). AM6 mentions that seeing someone else struggle with a task, makes that you realise that you are not the only one, which increases your self-efficacy (Interview AM6).

"No, I do not find that very interesting. What someone else... I would like to help someone, but not that I feel better because someone else cannot do it. It does give me a good feeling when I can help someone, but not I the sense: oh, look, she cannot do it and I can. I do not think that is important at all." (Interview AM5)
"Nee, dat vind ik niet zo boeiend. Wat een ander… Ik zou iemand willen helpen, maar niet dat ik me beter voel omdat een ander het niet kan. Dat geeft wel een goed gevoel als ik iemand kan helpen, maar niet van: o, kijk, zij kan het niet en ik kan het lekker wel. Dat vind ik helemaal niet belangrijk." (Interview AM5)

AM2 mentions that vicarious experience is nice for a first time of performing a new task. Then, it is nice to be able to see someone else perform the task before you will try it yourself. And also, if you eventually are trying it yourself and it does not work out well, it is nice to be able to see it another time (Interview AM2). But he emphasises that in the end their profession is really the doing it yourself, and you will gain confidence by doing it (Interview AM2).

"No. No, of course, for the first time it is nice to have seen it once, and eventually when you are going to do it yourself and if you do not do it well you can see it once more. But ultimately our profession is very much: doing, doing, doing. And that you become confident by doing it." (Interview AM2)
"Nee. Nee, natuurlijk, voor de eerste keer is het wel fijn om een keertje gezien te hebben, en uiteindelijk als je het zelf gaat doen en als je het niet goed doet dat je het dan nog een keertje ziet. Maar uiteindelijk ons vak is heel erg: doen, doen, doen. En dat je er zelfverzekerd in wordt door het te doen." (Interview AM2)

On the other hand, AM4 emphasises that vicarious experiences for students who are just starting their profession is important for their self-efficacy. Showing them how to do things, while giving them the impression that they are already capable of making a significant contribution, will boost their self-efficacy. This will increase their self-efficacy and their motivation from the beginning of their profession. So, vicarious experiences are important for self-efficacy, according to AM4 (Interview AM4).

"Yes, I think it is very important that you show it first. And then, under supervision, they do it themselves and later they can do it themselves, even the smallest things. That you do not just throw them in at the deep end. Which used to be the case." (Interview AM4)
"Ja, ik vind het ook heel belangrijk dat je het eerst voordoet. En dan gaan ze onder begeleiding dat zelf doen en later kunnen ze het ook zelf, zelfs de kleinste dingen. Dat je niet ze gewoon maar in het diepe gooit ofzo. Wat vroeger wel zo was." (Interview AM4)

Physiological arousal

AM1 says that he thrives best in a situation where is beeper goes off because he must run to the OR due to for example a massive bleeding. So, in a situation with psychological arousal, while he is sure that he can do the job (Interview AM1). Likewise, AM6 mentions that healthy tension in certain situations increases his self-efficacy and excitement for the job (Interview AM6).

"Yes, healthy tension. Yeah, like a trauma care or something. That is just always fun. You do not know what you are going to get. It can be terrible, but that is just yes, that is what we refurbish from. Our deviation, yes, the worse it is for the patient, the more fun it is for us." (Interview AM6).
"Ja, gezonde spanning. Ja, dat is bijvoorbeeld een trauma opvang of zo. Dat is gewoon altijd leuk. Je weet niet wat je krijgt. Het kan verschrikkelijk zijn, maar dat is gewoon ja, daar knappen wij van op. Onze afwijking hoor, ja, hoe slechter het voor de patiënt is, hoe leuker het voor ons wordt." (Interview AM6)

AM3 notices that physiological arousal does not impact the self-efficacy, but the effect is the other way around. Meaning that in a tensive situation, you believe in your capabilities to do the task, but you know that you must be alert (Interview AM3). For AM5, the physiological arousal is not that important for his self-efficacy as well (Interview AM5).

AM2 mentions that it dependent on the situation, but that physiological arousal might absolutely impact your self-efficacy as you worry a bit more than normal in those difficult situations. It might be the case that you forget to do some things because of the difficulty of the situation, but that will become less by gaining experience. When one performs a reanimation for the hundredth time, the physiological arousal will be less, and you will have gained more confidence in your capabilities over time (Interview AM2). Likewise, AM4

mentions that if you experience too much physiological arousal, so stress, this will wear you out, so you will have to find a way to reduce the amount of stress. Your self-efficacy will increase if you are able to reduce the amount of stress, as it will make you believe that you are calm and aware of your capabilities (Interview AM4). AM7 also says that you will go home satisfied if you are able to keep your head cool in those situations. So, that you are able to still bring a stressful situation to a good end, despite the physiological arousal taking place, is what gives you faith in your own capabilities (Interview AM7).

> "Yes, well, if you keep your cool in a situation like that, then you go home satisfied." (Interview AM7)
> "Ja! Nou ja, als je het hoofd koel houdt in zo'n situatie, dan ga je toch wel tevreden naar huis." (Interview AM7)

Self-actualisation

Also self-actualisation is considered a very important motivational factor for motivation by AM2, as the profession is continuously changing and there are always new studies and ideas. It is really part of the profession according to him (Interview AM2). AM4 and AM5 also find self-actualisation very important, as it is fun to learn new things (Interview AM4; Interview AM5).

For AM6 and AM7, learning new things and developing yourself, is important but not very important for your motivation (Interview AM6; Interview AM7). Learning new things will keep you sharp, according to AM6 (Interview AM6). AM7 says that he wants his profession to remain challenging, but that new things sometimes are disturbing as it becomes messy. It is less relaxed than working with something you already know how it works. That is for him especially the case for new materials. But he finds it important to keep developing as a person, as the profession develops as well. He thinks that self-actualisation is something fun to do next to his profession, but it does not impact his job satisfaction as it does not result in going home happy or unhappy (Interview AM7).

> "Yes, yes, yes, then it is nice to keep learning new things and developing yourself. It just keeps you sharp. It is also just good for you. Important, not very important." (Interview AM6)
> "Ja, ja, ja, dan is het wel leuk om nieuwe dingen te blijven leren en je te ontwikkelen. Dat houd je ook gewoon scherp. Het is ook gewoon goed voor je. Belangrijk, niet zeer belangrijk." (Interview AM6)

For AM3 is self-actualisation a less important factor, as he would not know what new things he still should learn. He says that a certain moment you will feel like you have seen everything. Then you can still go into depth on certain pathologies, but self-actualisation has become less important for your motivation (Interview AM3).

7.3. Ranking of the motivational factors by importance

All anesthesia assistants agreed on that all these motivational factors are important to them in their monitoring task (see Section 7.2). Subsequently, they ranked the motivational factors from least important to most important for their motivation in patient monitoring, see Table 2. According to AM0, in principle there is not really one of the motivational factors that is on top in importance, as a mix of all the factors together is crucial for his motivation (Interview AM0). And it depends per day which motivational factor is of most importance (Interview AM0).

Table 2. Ranking of motivational factors by anesthesia assistants, according to how important they are for their motivation in monitoring. Least important factors were given a number 5, to most important factors a number 1.

		Interviewed anesthesia assistants							
		AM0	**AM1**	**AM2**	**AM3**	**AM4**	**AM5**	**AM6**	**AM7**
Motivational factors	*Autonomy*	2	5	3	1	1	2	1	3
	Relatedness	4	1	1	4	5	5	3	4
	Competence	1	2	2	3	3	4	2	2
	Self-efficacy	5	4	4	2	2	3	4	1
	Self-actualisation	3	3	5	5	4	1	5	5

To AM0, the most important is deriving pleasure from your work, which for AM0 entails thinking and acting on your own. The motivational factors of autonomy, competence and self-actualisation are important in this, and relatedness to a lesser extent as he finds it important to gain appreciation from his team but does not want to have relatedness all the time. He finds competence the most important factor, and after that autonomy and self-actualisation. Relatedness is important, but less important than competence and autonomy. Self-efficacy he does not find that important (Interview AM0).

Relatedness is the most important factor for AM1 in his work, so the colleagues and his team. Autonomy is also important to AM1 in his daily job as he wants to control how his daily schedule looks like, but not purely within monitoring, then he finds autonomy the least important factor. He believes that if a clever technology can add to patient monitoring, he should not have to take autonomy in that as well (Interview AM1).

"What I find very important in my work is the relatedness. So, the colleagues, the team. I think that is perhaps the most important thing" (Interview AM1)
"Wat ik heel belangrijk vind in mijn werk is de verbondenheid. Dus de collega's, het team. Dat vind ik misschien wel het allerbelangrijkste" (Interview AM1)

For AM2, the motivational factor of relatedness is the most important factor for motivation. AM2 values the relatedness, both with the task and his team, his colleagues. Although you are also often alone behind the sterile drapes, in between all tasks there is a continuous feeling of relatedness. Especially if something goes wrong, relatedness is a big factor (Interview AM2). In difficult situations, the anesthesia assistant and anesthesiologist collaborate and exchange knowledge, as the anesthesiologist also does not always know everything, so you can help each other. If you feel connected to each other, as well as with the actions you are doing, if often works out well (Interview AM2).

If AM2 must choose, then the self-actualisation factor is the least important factor for motivation. For this decision, he also takes an estimation of the motivation of his colleagues into consideration, as he says that they feel safe and easy in what is already there and everything new that adds to that is a bit of a hurdle for them (Interview AM2). He then puts the factors of autonomy and competence in between. He likes autonomy, as that is part of his profession, and also feeling competent for the monitoring task and responsibility means that you are doing your profession well (Interview AM2).

To AM3, the most important factor is autonomy, followed by self-efficacy, competence, relatedness, and finally self-actualisation (Interview AM3). AM4 also finds autonomy the most important motivational factor, so you can still have influence yourself. As second and third factor in importance, he mentions respectively self-efficacy and competence, as you must learn and trust, as well as keep thinking for yourself. Learning new things, self-actualisation, is a bit more sided, and mentioned as fourth factor by AM4. These four factors lie very close to each other for AM4, after which there is a gap to the last factor. The relatedness factor is the least important for the motivation to monitor for AM4, as he finds that not very important during the monitoring and more important in other tasks (Interview AM4).

"Autonomy is important to me. So you can still influence it yourself, huh?" (Interview AM4)
"Autonomie vind ik wel belangrijk. Dus dat je zelf ook invloed er nog op hebt hè?" (Interview AM4)

Self-actualisation is the most important motivational factor for AM5, as learning new things and developing talent is just what he loves himself (Interview AM5). Relatedness is the least important to him, as the anesthesia assistant works a lot independently. Indirectly he thinks anesthesia assistants feel connected, but in the end, they have to do the task themselves. Autonomy, self-efficacy, and competence are somewhere in between, and less clear in order for AM5 (Interview AM5).

"Yes, these two are really the most obvious: relatedness and self-actualisation … Yes, relatedness the least and self-actualisation the most important. And the rest is basically: yes, something like that." (Interview AM5)
"Ja, deze twee zijn echt het duidelijkst: verbondenheid en zelfactualisatie … Ja, verbondenheid het minst en zelfactualisatie het belangrijkst. En de rest is eigenlijk: ja, zoiets." (Interview AM5)

Autonomy is the most important motivational factor to AM6, as having your own working place and responsibilities is what he likes the most about their profession. You are responsible for everything you do. And you can only do your tasks well and in a pleasant way if you are competent and know what you can do and what you cannot. That is why he puts competence on the second place of importance. Relatedness with the team and colleagues is put on the third place, as working with a nice team in contrast to with a team in which it does not work out can make or break your day. However, if you have a nice team but cannot do anything yourself you will still have a bad day, so he rather has an unpleasant team in which he can do everything

himself. For that reason, autonomy is more important than relatedness to him. Self-efficacy is important to AM6, but he feels that if you are competent then you can do it, and then you should not make it difficult by doubting about your own competencies. Self-actualisation comes in last place, as AM6 prefers all the other four factors above learning new things (Interview AM6).

For AM7, the most important motivational factor is self-efficacy. That entails for him that you can do the right things, and can face challenges, and go home happily with the feeling that you did well today. On the second, third, and fourth place come respectively feeling competent, so competence, autonomy, and relatedness. Self-actualisation is important for AM7, but in these five factors the less important one for his profession. As that is something that is always enjoyable to do, but whether he has learned new things or not will not affect his job satisfaction. It is not the case that he will go home happier if he has learned new things (Interview AM7).

"That self-efficacy so to speak, belief in your own ability, that is just, that one I find the most important. … That you can do the right thing and face challenges, that you just go home happy, you know? I did well today. I think that is important." (Interview AM7)

"Die zelf-effectiviteit zeg maar, geloof in je eigen kunnen, dat is gewoon, die vind ik dan het belangrijkste … Dat je het juiste kan doen en uitdagingen aankunt, dat je gewoon happy naar huis gaat, weet je wel gewoon? Ik heb het goed gedaan vandaag. Dat vind ik wel belangrijk." (Interview AM7)

7.4. Relations between the motivational factors

As some motivational factors might be interrelated, the anesthesia assistants were asked whether they identify relations between the motivational factors. This is important, as impact on one of the motivational factors may this way impact multiple motivational factors. The relations between the motivational factors are visualised in Figure F.1 in Appendix F. Some explanations of the identified relations by the anesthesia assistants are visible in Figure 13.

AM0 mentions that some important competencies at the OR are responsibility, meaning that one can analyse by themselves and solve problems, clinical reasoning, collaborating, and taking initiative (Interview AM0). The different motivational factors of competence, autonomy, relatedness, and perhaps self-efficacy are reflected in these.

According to AM1, AM4, AM6, and AM7, competence and self-efficacy are related (Interview AM1; Interview AM4; Interview AM6; Interview AM7). Because if you know what you are doing, and if you feel competent, you also believe in yourself (Interview AM1; Interview AM4; Interview AM6). AM6 mentions that people can also be self-confident without having competencies, but that that is not a good thing (Interview AM6).

"If you feel competent, if you know you can do something then your self-confidence will follow naturally. And the people who are enormously confident, but cannot do it, those should scare you a bit." (Interview AM6)

"Als je je competent voelt, als je weet dat je iets kan dan volgt je zelfverzekerdheid vanzelf. En de mensen die enorm zelfverzekerd zijn, maar het niet kunnen, daar moet je een beetje bang van worden." (Interview AM6)

Competencies is what you must learn in the beginning, you have to dare to take it on, which results in self-efficacy. But this starts with curiosity to learning, connected to the motivational factor of self-actualisation. You must want to learn new things, and gain competencies, which then results in self-efficacy (Interview AM4). AM1 also sees that self-actualisation and competence are in a certain way connected to each other (Interview AM1). With that, AM1 and AM4 see a relation in the angle of competence, self-efficacy, and self-actualisation (Interview AM1; Interview AM4). Additionally, AM4 sees an extra result of learning new things and gaining competencies, next to self-efficacy, namely autonomy. As you need faith in yourself to be able to make choices (Interview AM4).

"But competencies and self-efficacy belong together again, of course. If you know what you are doing, then you also believe in yourself. If there is a relationship, it is between competence, self-efficacy and self-actualisation. In that corner." (Interview AM1)

"Maar competenties en zelfeffectiviteit horen wel weer een beetje bij elkaar natuurlijk. Als je weet wat je aan het doen bent dan geloof je ook in jezelf. Als er een relatie is, dan zit dat tussen competentie, zelfeffectiviteit en zelfactualisatie. In die hoek." (Interview AM1)

Additionally, a relation between competence and autonomy is found by AM2 as well as by AM4 and AM6 (Interview AM2; Interview AM4; Interview AM6). If you feel competent, you are able to make more choices on your own. If you know this is the right choice, you can handle on your own without the need to double check with the anesthesiologist (Interview AM2). AM4 and AM6 also mention that one needs competencies to have

autonomy (Interview AM4; Interview AM6). If one is not competent, they should not have autonomy. AM6 says that the OR team should identify it when one does not have sufficient competencies, but that in practice this is not always the case (Interview AM6).

"If you feel competent then you have more choices that you are making on your own. So... Of course, you can always call, but if you know that this is the right one and you have trust, you will do it on your own, without double-checking with your anesthesiologist: yo, I want to do this and that, what do you think of that? But no, then you just do it." (Interview AM2)

"Als je je competent voelt dan heb je meer eigen keuzes die je maakt. Dus .. Je kunt natuurlijk altijd bellen, maar als je weet dit is de goede en je hebt er vertrouwen in dan doe je het ook in je eentje zonder het te gaan dubbelchecken met je anesthesioloog van: joh, ik wil dit en dat gaan doen, wat vind jij ervan? Maar nee, dan doe je het gewoon." (Interview AM2)

AM1 and AM5 mention that to them there is no relation between relatedness and autonomy (Interview AM1; Interview AM5). As with autonomy one must do the task alone, while relatedness is connection with a team (Interview AM5). AM1 also finds relatedness the opposite of autonomy (Interview AM1). In contrast, according to AM6, there is a connection between relatedness with the task and the feeling of responsibility, which is part of autonomy (Interview AM6). AM7 mentions that relatedness and autonomy might seem contradictory, but that it is not really the case. The anesthesiologist allows you to make choices, while also giving you the option to call if necessary. That is a combination of both relatedness and autonomy, and therefore these factors are linked together (Interview AM7).

"Yes, it is so to speak if the anesthesiologist, say, is saying to you, you can make your own choices, but you can always call me. Then you also have a bit of relatedness, but also your autonomy, right? So, I think that fits together nicely." (Interview AM7)

"Ja, het is zeg maar als de anesthesist zeg maar tegen jou zegt, van maak maar je keuzes, maar je mag me altijd bellen. Dan heb je ook een beetje die verbondenheid, maar ook je autonomie toch? Dus dat vind ik wel mooi bij elkaar passen." (Interview AM7)

According to AM2, relatedness and self-actualisation are related, because he thinks that if you are connected, you are enabled to learn new things because that often happens together with others. He says that some people have a lot of knowledge on a specific subject, and if they get the opportunity to teach about it and others get the opportunity to learn from them this will enable them to learn from each other. And this will eventually also influence your self-efficacy, as you learned something new with your colleague which you found interesting, meaning that you might immediately apply it yourself too (Interview AM2).

The factor of vicarious experiences that may influence self-efficacy, is also somewhat connected to relatedness, says AM1. If he sees others solve a difficult case, and they worked really hard, he is really proud of them, which is a feeling of solidarity, meaning that there is a sort of relation between self-efficacy and relatedness (Interview AM1).

AM5 sees a connection between self-efficacy and self-actualisation, because if he has learned new things that will increase his believe in his capabilities in doing those things. Because, he learned it, which means that he knows that he is doing it the right way (Interview AM5).

"My self-efficacy and my self-actualisation, I think that they belong together too. Because if I have learned new things, then I believe that I can do things and that I have learned them and that I am therefore doing them in the right way." (Interview AM5)

"Mijn zelfeffectiviteit en mijn zelfactualisatie, die vind ik ook voor mij bij elkaar horen. Want als ik nieuwe dingen geleerd hebt, dan geloof ik dat ik dingen kan en dat ik het geleerd heb en dat ik het dan dus op de juiste manier doe." (Interview AM5)

In contrast, AM3 and AM7 say that self-actualisation is not related to the other motivational factors (Interview AM3; Interview AM7). It stands alone, according to AM7, and is something personal. It is dependent on whether you feel like it at that time. AM7 would not be excited about that every day (Interview AM7).

Likewise, relatedness is not related to the other motivational factors, according to AM3. Relatedness is a nice feature to have. It is not great to have to work in an environment with a negative atmosphere, but he never lets that influence him, as he is just doing his own thing. If someone does not like something, he feels like that is more their problem than his. And self-actualisation is something you have to go after by yourself (Interview AM3). Likewise, AM4 does not see a relation between relatedness and one of the other motivational factors. None of the factors influences the team nor colleagues, and vice versa, as it does not influence his feelings what people say (Interview AM4).

"No, not so much. No, no, it does not affect the team or colleagues. You know, I do not really care what people say about it. Again. You have your own feelings about things anyway." (Interview AM4)
"Nee, niet zo. Nee, nee, het heeft geen invloed op het team of collega's. Weet je, het maakt mij niet zoveel uit wat mensen ervan zeggen. Nogmaals. Je hebt toch je eigen gevoel over dingen." (Interview AM4)

AM3 is convinced that autonomy and self-efficacy go together, as the one cannot exist without the other. Being able to make your own choices in what you do and do not, makes you believe in your own capabilities, and that is a reciprocal action. And finally, this will make you feel competent (Interview AM3).

"That autonomy and self-efficacy just go together. One cannot exist without the other, I think. That you can make your own choices in what you do and do not do. That makes you believe in your own abilities. And that is an interaction process. And that is what makes you competent." (Interview AM3)
"Die autonomie en zelfeffectiviteit die horen gewoon bij elkaar. De één kan niet zonder de ander, denk ik. Dat je zelf je keuzes kan maken in je doen en laten. Daardoor geloof je weer in je eigen kunnen. En dat is een wisselwerking. En daardoor word je competent." (Interview AM3)

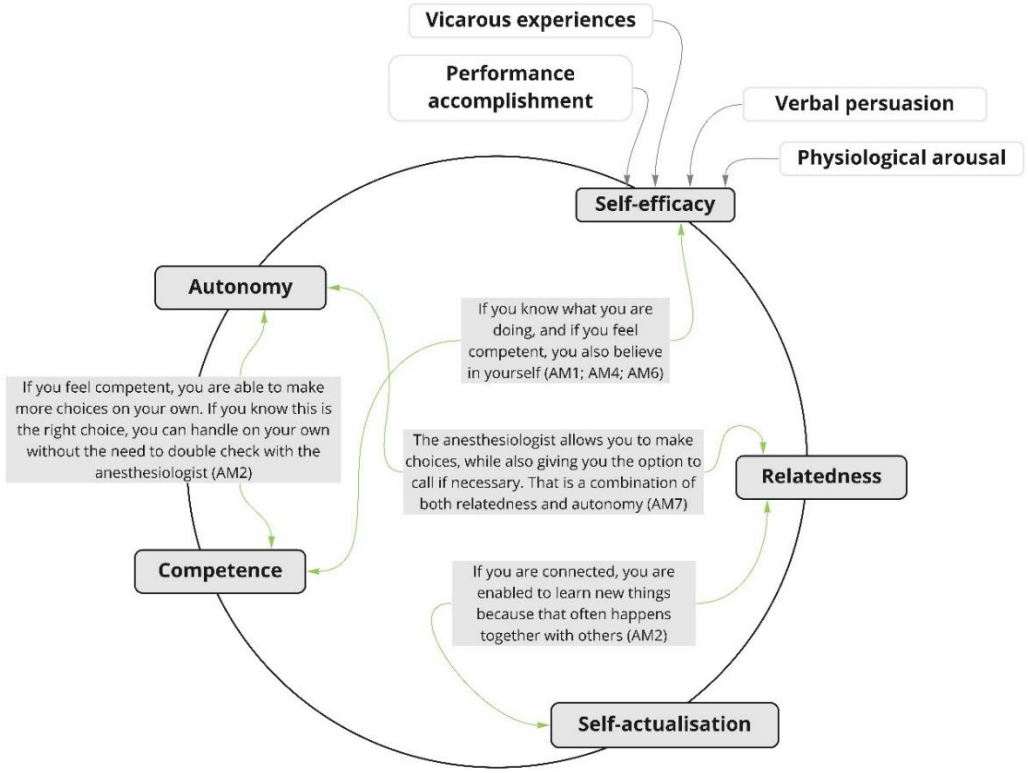


Figure 13. Visualisation of some of the relations between the motivational factors as identified by the anesthesia assistants. (Own visualisation). Some of the relations as identified by various anesthesia assistants are visualised, including the reason why this relation was identified. The green lines indicate that there is a relation present between the motivational factors. This figure indicates that the motivational factors are not stand-alone, and thus may negative or positive impact on one of the motivational factors also impact other motivational factors.

7.5. Influence of AI-assisted monitoring on the motivational factors

If an algorithm would only give suggestions, or says what you could do, then AM0 does not see that as a threat to his competencies or autonomy. As, he would still keep thinking himself, as the computer might also make a mistake (Interview AM0). AM3 also does not think that the introduction of AI would affect his motivation. He says that he will stay motivated, as he believes that such a system would never take-over all your work. He must pick up the patient, connect the patient to the devices, which are all tasks that the patient cannot perform (Interview AM3).

Likewise, AM7 thinks that use of AI would not change much, and thus does not impact the relatedness with the team (Interview AM7). However, AM7 thinks that it will increase competence. As at the moment you try some treatment and if it works you often do not know why it worked. With predictions of AI, you have more data on which you can base your argument, might know better what you are doing, and why this specific

treatment worked (Interview AM7). Additionally, it might positively influence autonomy, as it will help you to decide, and as you have more information to base your decision on you will feel more self-confident to make the decision (Interview AM7).

"No, I think it has a positive influence on your competence. That you... What I said earlier that you just know what you are doing. And then you feel competent. Now sometimes, we just do it and it works and we think, well, we did a good job, but why it worked, we often do not know that and I find that frustrating myself sometimes. I would then like to know, why did this work and why did the other one not?" (Interview AM7)
"Nee, ik denk juist dat het een positieve invloed heeft op je competent zijn. Dat je.. Wat ik al eerder zei dat je gewoon weet wat je aan het doen bent. En dan voel je je competent. Nu is het soms, we doen het maar en dan werkt het goed en denken we van nou, dat hebben we goed gedaan, maar waarom het werkt, dat weten we dan vaak niet en ik vind dat zelf af en toe wel frustrerend. Ik wil dan graag weten, waarom werkte dit nu wel en dat andere niet?" (Interview AM7)

Intrinsic motivation might decrease if everything is predicted by AI says AM1. His fear is that if the device will predict for you what to do, you will lose the interest in your profession. That the device will take over the autonomy (Interview AM1). And, if all technical actions would be taken away, so you are working less technical, he would not like it anymore (Interview AM1).

AM2 can imagine that if a lot will be taken away, it will be more in line with the way the profession is in other countries, which would become less fun (Interview AM2). AM2 is scared that if the relatedness with the task becomes less due to AI, he will become more apathetic, which will increase the chances of making mistakes. Because you are less focused on the monitoring if you primarily believe that everything will be fine because AI will take care of it (Interview AM2).

"And with the tasks, if I feel less connected to them, it could also be that I become more lax. And that laxity might make you make mistakes sooner. So, if I largely think, yes, it will be all right or it will have been thought of, then you are a little less focused on it." (Interview AM2)
"En met de taken, als ik me daar minder bij verbonden voel zou het ook zodanig zijn dat ik dan wat lakser ga worden. En door die laksheid kun je misschien eerder fouten maken. Dus als ik grotendeels denk, ja, het zal wel kloppen of het zal wel goed komen of bedacht zal zijn, dan ben je er wat minder op gefocust." (Interview AM2)

If AI would take the form of making predictions as well as administering the medication to the patient, through coupling the monitoring to the medication pumps, and anesthesia assistants being present as control mechanism, AM1 is scared that his autonomy will disappear, as well as the relatedness. And competencies might no longer be interesting to develop (Interview AM1). According to him, taking choices out of the hands of anesthesia assistants by AI is not the solution, as making decisions by themselves, autonomy, is important (Interview AM1).

"Why do we not link the pumps to the heart rate and the blood pressure and also the registration to each other? And that we are present in the OR as a control mechanism. Dream image. The consequence of that is that autonomy goes away. That relatedness might become absence. Competencies are no longer interesting to develop." (Interview AM1)
"Waarom koppelen we de pompen niet aan de hartslag en de bloeddruk en ook nog de registratie aan elkaar? En zijn wij als controlemechanisme aanwezig op de OK. Droombeeld. Het gevolg daarvan is dat de autonomie weggaat. Dat de verbondenheid misschien wel gaat ontbreken. Competenties zijn niet meer interessant om te ontwikkelen." (Interview AM1)

AM0 mentions that he would want help, or support, from AI, but that he also finds it important that he can still continue to exercise his competencies. There must be a balance in that (Interview AM0). Likewise, he wants to continue to do the tasks himself, and keep autonomy. He likes it that he is able to do a lot by himself and can decide on how to do certain things. AM0 does not want any of the motivational factors to disappear due to AI. There must be a consultation between AI and the staff (Interview AM0).

On the other hand, AM6 thinks that if the computer could precisely monitor the anesthesia during the operation, the anesthesia assistant might be enabled to do other fun tasks in the meantime. For example, tasks of anesthesiologists. Then, he thinks it works positively for motivation (Interview AM6).

"And, you know, maybe the computer can then monitor the anesthesia per operative very well, so that an anesthesia assistant can do other fun tasks. Maybe we will just prick lines in the meantime, because the anesthesiologists have become too expensive. Yes, I do not know, right? And then suddenly, it is no big deal anymore." (Interview AM6)
"En, weet je, misschien kan de computer dan de narcose per operatief heel goed in de gaten houden, zodat een anesthesiemedewerker andere ook leuke taken kan gaan doen. Misschien gaan wij in die tussentijd wel even draden prikken, omdat de anesthesiologen te duur zijn geworden. Ja, weet ik niet, hè? En dan is het weer ineens helemaal niet erg." (Interview AM6)

The introduction of a smart system that will give monitoring advices is not something that would cause his job to not be enjoyable anymore. But if everything will be automated, AM1 would not like it anymore (Interview AM1). Likewise, AM6 would become very unhappy by a form in which AI would take over the monitoring and intervening, while the anesthesia assistant is on their own in a room looking at cameras of multiple rooms on a distance of the OR (Interview AM6). He says that the impact on autonomy can take on different forms. In the sketched situation of the AI deciding on the anesthesia and the anesthesia assistant is only watching and intervening if something really bad happens, then the autonomy is compromised. On the other hand, if this enables you to be in multiple rooms and do other tasks, your autonomy may increase (Interview AM6). The same goes for competence, as you will become less competent if the computer takes over the thinking, while you may become more competent if you check for yourself whether the computer is making the right decisions while on top of that you can do other tasks (Interview AM6).

"Autonomy can go either way. Because, hey, if in the first situation it is described that AI is going to determine how the anesthetic is and you sit there and watch, and you only intervene if something really crazy happens. Yes, then your autonomy is compromised. If it would be such that, for example, you could be in multiple rooms and do other tasks, you might get much more autonomy, so it could go either way. It is the same as with your competence: if you let the computer think for you and stop thinking for yourself, then you will not become competent anymore. If, on the other hand, you think and watch whether the computer is doing the right thing and perhaps work on several things at once, you may actually become much more competent." (Interview AM6)

"Autonomie kan alle kanten op. Want hè, zo is als in de eerste situatie geschetst wordt van AI gaat bepalen hoe de narcose is en jij zit erbij en je kijkt ernaar en je grijpt alleen in als er echt iets geks gebeurt. Ja, dan wordt je autonomie aangetast. Als het zo zou zijn dat je bijvoorbeeld met meerdere kamers kan zijn en je andere taken doet, dan krijg je misschien wel weer veel meer autonomie, dus dat kan alle kanten op. Hetzelfde als met je competentie dus: als jij de computer voor jou laat denken en dus ook stopt met zelf nadenken, dan word je niet meer competent. Als je juist nadenkt en kijkt of de computer het goede doet en misschien met verschillende dingen tegelijk bezig word je misschien juist veel competenter." (Interview AM6)

Being in a room on your own looking at cameras, will make you very unhappy as the relatedness will disappear says AM6. However, if you are in the room with different colleagues, which you can ask what they are doing and whether you can help, then it will become much more enjoyable and relatedness is not impacted negatively (Interview AM6).

According to AM6, whether AI will impact your motivation negatively or positively really depends on what you make of it. Most of all, it is important to be involved in the introduction of AI. If you do not participate in that, it will pass you by (Interview AM6).

7.6. Reflection on the results on motivation

From the investigation of the motivational factors that are of impact on their motivation in their task of patient monitoring, it appears that the motivational factors of autonomy, relatedness, competence, self-efficacy, and self-actualisation are all important to very important for these anesthesia assistants. This demonstrates that the presence of these motivational factors in the theoretical motivation model is appropriate. Furthermore, none of these factors is clearly standing out in importance compared to the other motivational factors. Various, work context specific, relations between the motivational factors were identified by these anesthesia assistants, meaning that positive or negative impact on one of these motivational factors also may impact the motivational factors that are related to the first.

The expected impact of AI on these motivational factors varies per form of AI-assisted monitoring as well as per anesthesia assistant. The influence may be positive, neutral, or negative, according to the anesthesia assistants. The form of AI-assisted monitoring that gives suggestions to anesthesia assistants, may have a positive effect on autonomy and competence, by helping to make the right decisions, have no impact on motivation, or may negatively impact intrinsic motivation, by for instance decreasing the relatedness. A more automated form of AI-assisted monitoring may lead to the loss of autonomy, competencies, and relatedness with the team and task, but may also have a positive impact on amongst others autonomy and competencies by enabling to take on other tasks during the monitoring. To summarise, AI-assisted monitoring can have a consequential impact on these motivational factors, both positive and negative, and must therefore be carefully considered.

8. Educational module

This chapter comprises the last sub-question of "How can the knowledge on attitude and motivation of anesthesia assistants be used to build an educational module to support anesthesia assistants in their awareness and understanding of the impact of AI in their monitoring task?". Firstly, it will explain why and how an educational module could provide support to anesthesia assistants. Secondly, the design criteria for such a module that have emerged from the interviews with anesthesia assistants are discussed. Thirdly, the expert validation of a draft of the educational module by an anesthesia educator is discussed, including extra design criteria. Fourthly, the final design of the educational module is shown, building on the knowledge on the attitude and motivation of anesthesia assistants, and design criteria of the anesthesia assistants and anesthesia educator.

8.1. Educational module to provide support

As explained in Section 4.2, the education of anesthesia assistants comprises an in-service educational programme, as well as separate refresher courses in continuing education aside the profession. From the interviews with anesthesia assistants, see Chapter 6 and 7, it becomes clear that there is little knowledge about the possibilities in AI-assisted monitoring among anesthesia assistants, as well as insecurity about the impact of AI on their motivational factors.

On the one hand, anesthesia assistants see a lot of potential in AI-assisted monitoring that could help them in their monitoring task. On the other hand, they are insecure about what the possibilities in AI-assisted monitoring are, as well as what will be left of their job in the future. Unawareness of the real possibilities and risks of AI is a barrier for anesthesia assistants to know the advantages that AI could have for them, and to be able to think along with AI developers in how AI development could be beneficial for anesthesia (Kelly et al., 2019).

In order to support anesthesia assistants in the use of AI-assisted monitoring in their monitoring task, an educational module that increases awareness and understanding on the use of AI-assisted monitoring and the impact of AI in their monitoring task could be helpful. An educational module is a logical way to support anesthesia assistants, as educational modules are already part of their profession. The results of this study provide input for the educational module.

In this way, the educational module could serve two goals. Firstly, the anesthesia assistant can be assisted towards understanding how AI could support them. For this, one needs to be informed about what AI entails, and gain insights on what basis AI makes its decisions and what AI could mean to them in their monitoring task. An educational module about AI could thus play a role in creating understanding and in expectation management. Secondly, the educational module can give the anesthesia assistant insight in the motivational factors that are important for their motivation in their monitoring task, and subsequently the impact that AI might have on these motivational factors. This is important for their development towards becoming deliberate professionals, as their motivation is of impact on their professional behaviour. This means that making conscious decisions about their behaviour in practice is intertwined with their motivation to perform this practice. Insight in their own motivation enables the anesthesia assistants to be aware of the impact of their motivation in decision-making. Clearly, this second goal is thus not aimed at increasing the anesthesia assistants' motivation for AI-assisted monitoring. Moreover, the subsequent insight on the impact of AI on their motivation is critical for them to consciously consider and determine how they want to work with AI. And what form, on the scale of minor to major impacting their job (see Chapter 5), they personally think AI should take on in their monitoring task. Especially as the unfamiliarity with AI-assisted monitoring might raise fears of take-over of their profession. Gaining awareness on the concrete, real impact of AI on their motivation allows them to deliberately make decisions in how to work with AI-assisted monitoring.

8.2. Design criteria: requirements by anesthesia assistants

Before such an educational module is developed, one needs to make sure that it connects to the knowledge of anesthesia assistants about AI and their interests in what they want to learn about it. One must as well consider practical issues as where to implement such a module into their job and education, based on information by the future users. For this, the results of the non-operationalised interview questions on whether there is interest in an educational module among the anesthesia assistants was used, as well as on what they would want the educational module to include, what they would want to learn about AI, and whether they

would want to learn about their motivation. These design criteria for the educational module are shown in Table 3. Furthermore, the module should fit with the learning and teaching practice that is customary in their profession, based on information of an aesthesia assistants' educator. This is done via the expert validation, see Section 8.3.

Table 3. Design criteria for the educational module on the basis of the input of anesthesia assistants gained through the semi-structured interviews as well as through literature research.

	Design criteria for the educational module
1.	The educational module can only be used if AI-assisted monitoring is implemented and in use, or foreseen in the near future.
2.	The educational module must take a form that can both be used in the educational programme as well as in a refresher course.
3.	The educational module must connect to the practical profession of anesthesia assistants to involve them. It has to be practical and tangible, giving anesthesia assistants the possibility to practice with AI and analyse what happens.
4.	As anesthesia assistant have higher learning abilities if they are supported by colleagues, they must be enabled to both learn individually as well as interact with peers.
5.	The educational module should consist of different sub-modules, based on the scaffolding approach. And the revised taxonomy by Bloom must be used to build up the sub-modules of the educational module.

From the results on perception, see Section 6.1, it became clear there is interest in AI among the anesthesia assistants. Furthermore, the results from the non-operationalised interview questions also indicated that anesthesia assistants are also interested in learning about AI through an educational module (Interview AM0; Interview AM1; Interview AM2; Interview AM3; Interview AM4; Interview AM5; Interview AM6; Interview AM7). While AM7 says that his team is very willing to learn new things, he also doubts whether this also applies to his older colleagues regarding AI. On the other hand, he also mentions that the information still should be shared as it will be present in their future profession (Interview AM7). AM7 was also asked specifically whether there was interest in learning about the impact of AI on motivation, which was answered positively (Interview AM7). As both the subjects of AI, and motivation and the impact of AI on motivation must be covered, the decision is made to make two separate parts for the educational module. The anesthesia assistants mentioned various requirements for the educational module.

Firstly, they think that an educational module about AI will only be useful if AI is already implemented and in use, or that will happen in the near future (Interview AM2; Interview AM4; Interview AM6). A practical example is necessary for the understanding, according to AM6 (Interview AM6). If AI is not in operation yet, the expectation is that there will be no interest among anesthesia assistants (Interview AM2). Although AM5, AM6, and AM7 also mention that it would be good to inform them in advance, and include them in the process, AM2 says that something that is not applicable is immediately forgotten (Interview AM2; Interview AM5; Interview AM6; Interview AM7).

> "But I think it is only really useful if it is already operating and things like that. Because it is often obligate to learn it on the work floor with lessons and things like that and if it is actually there and exists, only then it is useful in the education in my opinion." (Interview AM2)
>
> "Maar ik denk dat het inderdaad pas erg nuttig is als het al werkzaam is en dat soort dingen. Want je leert het vaak ook verplicht op de werkvloer met lessen en dat soort dingen en als het er dan echt daadwerkelijk is en bestaat dat het dan in mijn ogen pas nuttig is in de opleiding." (Interview AM2)

Secondly, the module must be both part of the educational programme as well as part of a refresher course (Interview AM2; Interview AM3; Interview AM4; Interview AM5). So not only during the educational programme, as new approaches by recently graduated anesthesia assistants are not easily accepted by older anesthesia assistants (Interview AM5).

Thirdly, it was often mentioned that the educational module must be practical in order to connect to the practical profession as well as involve the anesthesia assistants (Interview AM2; Interview AM3; Interview AM6). Anesthesia assistants learn through practice and trial and error, also known as single-loop learning. For that reason, the educational module must contain something practical and tangible in which anesthesia assistants can practice with AI and analyse what happens; only narrative explanation is not enough (Interview AM7). First an explanation of how AI works, followed by what you can do with it, and ending with something practical is the best way according to AM2, AM5 and AM6 (Interview AM2; Interview AM5; Interview AM6). If anesthesia assistants are able to practice with AI, they will also understand its purpose in the profession

(Interview AM2). In that way they can gain insight in how they personally can and want to apply AI in their monitoring. This will improve efficiency and enables them to handle more quickly and accurately.

"And we are doers. We just have to do it. So, put us behind that thing and we will freewheel a bit. That is what we benefit the most from, and that is the way we learn the most from it." (Interview AM3).
"En wij zijn doeners. Wij moeten gewoon doen. Dus zet ons maar achter dat ding en we freewheelen wel wat. Daar hebben we het meest aan, daar leren we ook het meeste van." (Interview AM3).

Fourthly, from literature research it appears that anesthesia assistants work in a very practical environment, as well as in a social environment with colleagues and anesthesiologists (see Chapter 4). Accordingly, the anesthesia assistant has a higher learning ability if he is supported by colleagues (see Chapter 2). Connecting to the fact that the educational modules of anesthesia assistants in continuing education often consist of both live talks or classes, and e-learnings, see Section 4.2, this educational module should comprise both classes and e-learnings for the refresher courses (Interview AM7). With that, anesthesia assistants are enabled to learn individually as well as interact with peers to increase their learning ability. Then they can find out what role AI could play in their monitoring task, what motivational factors are important, and what impact the use of AI-assisted monitoring might have, both individually and in groups.

Furthermore, the educational module must consist of different sub-modules, based on the scaffolding approach (see Chapter 2). This enables the learners to learn at their own pace. With that, giving them autonomy in choosing which steps to take at what point in time. Between every sub-module in the educational module there must be time and space to exchange knowledge and insights between colleagues as well as to bring the learned information into practice in the profession, to create learning potential and encourage and motivate a learner to take a next step in their learning process (see Chapter 2).

Additionally, the revised taxonomy by Bloom must be used to build up the sub-modules of the educational module, see Chapter 2. If the whole pyramid would be followed, the learning goals would comprise the thinking skills of remembering, understanding, applying, analysing, evaluating, and creating.

8.3. Expert input and validation

This expert validation is performed with Frank Janszen, an educator of the educational programme of anesthesia assistants of the LUMC. Firstly, background information on how the educational programme is build up by educational modules, what the refresher courses comprise, and how testing is performed in their education, is discussed in Section 8.3.1. Secondly, the educator validated the draft of the educational method, resulting in (extra) design requirements for the educational module by the expert, which are described in Section 8.3.2. However, as the educational module is not yet fully elaborated and not used in practice yet, a further validation in practice by users is necessary in the future, which is further described in Section 10.4.

8.3.1. Background information on the educational programme of anesthesia assistants

The educational programme consists of multiple educational modules, as physiology, anatomy, medical technology, and professional development. A module in the educational programme of anesthesia assistants comprises about 30 different parts. An educational module about medical technology is given in the second year of the study, and includes for example a part about the technical background of an ECG. This part may comprise a single or multiple lessons, so for example one lesson of two hours, or four lessons of two hours. A lesson may comprise all sorts of activities as lectures, working groups, and simulations. Educational modules about professional development are given each year (three subsequent years) in the educational programme. This varies from communication at the OR-complex, giving feedback, and handling conflicts. This educational module also focuses on quality innovation, and intervision, in which one looks at questions and problems together with colleagues (F. Janszen, educator of anesthesia assistants, personal communications, April 22, 2022).

Refresher courses exist in two forms, namely at the OR at the LUMC itself, where for example an anesthesia assistant or anesthesiologist gives a talk for other anesthesia assistants. But there is also a specific training institute of the LUMC, the 'Educatie Zorgsector', where every anesthesia assistant, also from outside of the LUMC, can register for refresher courses. These refresher courses are voluntary. Refresher courses could thus both be followed at the OR, as well as through the Educatie Zorgsector (F. Janszen, educator of anesthesia assistants, personal communications, April 22, 2022).

The educational modules of the programme comprise final tests, as well as different forms of tests in the separate parts. The refresher courses only have tests in part of the courses. Different forms of testing are used, varying from simple explaining what one has learned in class, to quizzes or theses, giving presentations, case study discussions, or scenario trainings.

8.3.2. Design requirements by the expert

The draft version of the educational module was valued positively by the expert. Based on a draft version of the educational module, as well as the theory used for the module, the expert came up with (extra) design requirements to further improve the module and make it even more compatible with the current educational methods used for anesthesia assistants' education. The design criteria of Table 3 were adjusted based on the input of this expert, see Table 4.

Table 4. Adapted design criteria for the educational module based on the input of the educator of the educational programme of anesthesia assistants of the LUMC.

	Design criteria for the educational module
1.	The educational module can only be used if AI-assisted monitoring is implemented and in use, or foreseen for the near future.
2.	The educational module must take a form that can both be used in the educational programme as well as in a refresher course. And the educational module parts must consist of lessons to fit into the educational programme of anesthesia assistants in training. The two parts of the educational module, on learning about AI and on learning about motivation and the impact of AI, could this way be included in respectively the educational modules of medical technology and professional development.
3.	The educational module must connect to the practical profession of anesthesia assistants to involve them. It has to be practical and tangible, giving anesthesia assistants the possibility to practice with AI and analyse what happens. A combination of theory lectures and case studies should be used, with mostly a focus on practice.
4.	As anesthesia assistant have higher learning abilities if they are supported by colleagues, they must be enabled to both learn individually as well as interact with peers.
5.	The educational module should consist of different lessons, based on the scaffolding approach. And the revised taxonomy by Bloom must be used to build up the lessons of the educational module. The learning goals must be adjusted to only the lower-order thinking skills of the revised Taxonomy of Bloom, namely remembering, understanding, and applying. Because the higher order thinking skills and matching learning goals of analysing, evaluating, and creating, are mostly too complex. This also means that multiple smaller learning goals can be used in the set-up of the educational module.
6.	Only formative testing should be used, meaning that a test is included, but in a form where students and the educator should look in practice what a student should know but does not know yet. Scenario trainings would fit as final test for the applying learning goal.
7.	There must be variation in the teaching styles, as people have different learning styles. By using different forms of lessons, such as class lectures, e-learnings, videos, case discussions, and working groups, everyone is addressed. For the learning on motivation, especially small working groups are a suitable learning stye.
8.	Use preparatory assignments before lessons, as this increases the learning ability of students.

The mentioned adaptations by the expert were the following. Firstly, just like the anesthesia assistants mentioned in the interviews, not only an educational module for trainer or refresher courses would be necessary, but it would also be very important to include such lessons into the educational programme of anesthesia assistants in training. With that, it would be spreading 'like wildfire', meaning that new students learn about AI and their motivation, and qualified anesthesia assistants will both learn through refresher courses as well as through the guidance of new students and later the discussing with new colleagues when the students have finished their educational programme (F. Janszen, educator of anesthesia assistants, personal communications, April 22, 2022).

Secondly, the two parts of the educational modules, one about AI, and one about motivation and the impact of AI, could fit into educational modules of the educational programme. The educational module part around AI could fit into the module of medical technology. The part around motivation and the impact of AI on motivation could fit into the module of professional development. It could then consist of different lessons. Gaining insight in your motivation and the impact that AI might have on this motivation would match with other parts in this module (F. Janszen, educator of anesthesia assistants, personal communications, April 22, 2022).

For the refresher courses, a similar set-up could be used. For example, in one month time multiple lessons on the subject of AI, and multiple lessons on the subject of motivation, spread over time (F. Janszen, educator of anesthesia assistants, personal communications, April 22, 2022).

Thirdly, the set-up of the educational modules using the taxonomy of Bloom (see Chapter 2) is in accordance with the LUMC-approach. However, the higher order thinking skills and matching learning goals of analysing, evaluating, and creating, are mostly too complex for anesthesia assistants. The students of the educational programme of anesthesia assistant vary from students that just finished high school, to doctor's assistants, mbo nurses, and hbo nurses, meaning a big difference in thinking and ability. As the profession is very practical, the lower order learning goals of remembering, understanding, and eventually applying match the best with the education of anesthesia assistants (F. Janszen, educator of anesthesia assistants, personal communications, April 22, 2022).

On all subjects, the students get theory lectures, with case studies. However, most of the subsequent lessons are learned in practice. They must see cases in practice and ask questions about the subject in practice, at the OR, to their work supervisor. So, they learn both through theory as well as practice. Repetition in the subsequent year about a subject is very important, also in refresher courses, to keep the knowledge alive. The subject must therefore be repeated each year in an educational module part. An example of how this is done in the LUMC educational programme, is that they start with cases of low-complex interventions, and the following year on more high-complex interventions. So, students have to think what it means for that specific patient category (F. Janszen, educator of anesthesia assistants, personal communications, April 22, 2022).

Only in the third year of the educational programme, the level of evaluating and analysing is reached when the students have to perform clinical reasoning at an intervention. For example, for the learning goal of evaluation, one must be able to indicate what could be and should be better. This is not a feasible learning goal within this relatively small part of an educational module. Also in the refresher courses, the analysing and evaluating learning goals are not feasible, as one part of an educational module is too short in time for that, and the subject is completely new to the anesthesia assistants. Reaching the application level, and thus using the learning goal of applying as ultimate learning goal, is matching the profession well (F. Janszen, educator of anesthesia assistants, personal communications, April 22, 2022). For that reason, the learning goals must be adjusted to the lower-order thinking skills of the revised Taxonomy of Bloom, namely remembering, understanding, and applying. This also means that multiple smaller learning goals can be used in the set-up of the educational module, which allows for more manageable results that can be tested easier.

Fourthly, on the subject of testing, the expert finds it more important to validate the educational module than giving a test that a student should pass. Hence, the suggestion is to use formative testing, meaning that a test is included, but in a form where students and the educator should look in practice what a student should know but does not know yet. This can be done by using quizzes, theses, case discussions, and scenario trainings. Case discussions can comprise a situation of a patient, where certain events occur, and predictions are made in the monitoring. Then, the students can discuss on what basis AI makes its predictions, and what would be the right practice. This connects to an ultimate learning goal in applying, as well as the practical side of anesthesia assistants which enhances enthusiasm. Also, scenario trainings would fit as final test for the applying learning goal. This includes a skills lab with a doll, that can amongst others be intubated, ventilated, and injected with infusions, as safe environment to practice as it would be a human (F. Janszen, educator of anesthesia assistants, personal communications, April 22, 2022).

Fifthly, there must be variation in the teaching styles, as people have different learning styles. This means that one person wants to first see it ten times before one wants to try the handling, as another one wants to immediately start handling. By using different forms in lessons, such as class lectures, e-learnings, videos, case discussions, and working groups, everyone is addressed (F. Janszen, educator of anesthesia assistants, personal communications, April 22, 2022).

For the learning about motivation, especially small working groups are a suitable learning stye. There, students can discuss the subject with peers to gain insight in their own motivation (F. Janszen, educator of anesthesia assistants, personal communications, April 22, 2022).

Two extra points of attention were mentioned by this expert. The timing of a lesson is important, meaning that gaining insight in your motivation as well as learning about AI is best planned at the start of the day, so the learned information can immediately be put into practice, increasing the chances that the anesthesia assistants can recall the information later on. In contrast, at the end of a long working day, one is mostly not very open to

learning something completely new. And, using preparatory assignments before lessons, increases the learning ability of students (F. Janszen, educator of anesthesia assistants, personal communications, April 22, 2022).

8.4. Design of the educational module

Based on the results of this study regarding the perception, attitude, and motivation of anesthesia assistants (see Chapter 6 and 7), as well as the design requirements as collected by the anesthesia assistants and anesthesia educator, an educational module is designed. This educational module proposal consists of two separate parts, in which the subjects of AI, and motivation and the impact of AI on motivation, are covered. Both parts are respectively explained in Table 5 and Table 6. The idea is that the parts could be used in the educational programme by incorporating them in the modules of medical technology and professional development, as well as using it in a refresher course for working anesthesia assistants. The parts each consist of multiple lessons. These lessons could take about 1 to 4 hours each. As the educational module parts are adjusted based on the design requirements and knowledge of anesthesia assistants, no prior knowledge on the subjects of AI or motivation is needed. However, some practical knowledge and experience on patient monitoring is needed to be able to participate in the case discussions and scenario trainings.

The structure of both parts is similar, with the same build-up in learning goals in correspondence with the taxonomy of Bloom (see Chapter 2). For the lessons, various teaching/learning forms are used. The difference between the scenario training in the beginning of the educational module and in the end, gives the anesthesia assistants insight in what they have learned. The final scenario training is meant as testing, in which the educational module is validated as well.

This educational module is not necessarily meant to motivate anesthesia assistants towards the use of AI, but gives anesthesia assistants insight in the motivational factors that may impact their motivation. However, to encourage anesthesia assistants in using the educational module, the module should contain some motivational component to trigger their participation. As described in Section 2.4, there must be a component triggering intrinsic motivation, as well as a component triggering extrinsic motivation. The intrinsic motivation is addressed by adapting to the attitude of the anesthesia assistants towards AI. This, by only addressing the forms of AI-assisted monitoring that are viewed positively. As well as being open about the impact that AI may have, and encouraging them in forming their own thoughts about AI and the personal impact it may have for them. Furthermore, by using their design requirements as basis to design the educational module. Additionally, the module is focused on practice, by using scenario trainings as well as giving time between the lessons to apply the learned information into the practice of the profession, and use working groups to stimulate the cooperative learning. All in all, adapting the module to their preferences. Additionally, the extrinsic motivational component in this module comprises the final scenario training that is used as form of testing, which often results in students wanting to perform well. Especially because the final scenario training is used as a final lesson, and a scenario training was also used as one of the start activities, meaning that one can see their own progress in knowledge and skills by completing the educational module.

In Table 5, the first part of the module is explained. The module part 1: 'Learning about AI' allows the anesthesia assistant to gain knowledge and understanding about AI, and more specifically AI-assisted monitoring. They gain skills in reading and checking the predictions made by AI in the monitoring, and ultimately solving problems by using AI in the monitoring and choose a procedure or treatment based on that. Potentially in a subsequent module, a distinction can be made into the different forms of AI, as machine learning and deep learning, and the different degrees of explainability that are connected to that. This could give insight in why a certain algorithm comes to a certain conclusion, giving insight in the 'black box' of AI.

Table 5. Educational module part 1: Learning about AI.

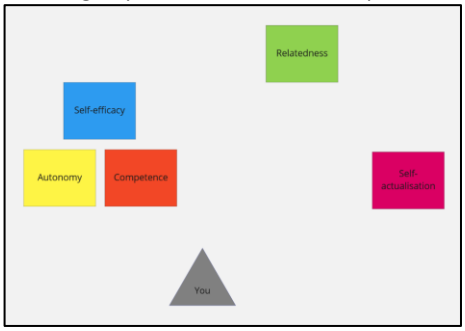
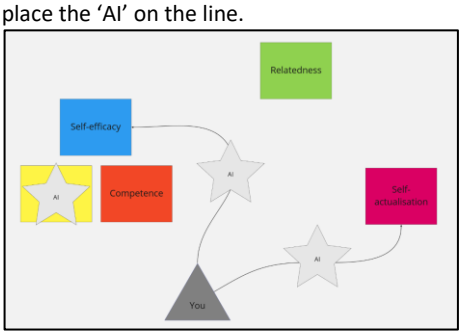
Part 1: Learning about AI	Description & Teaching form	Learning goal	Extra information
Lesson 1.1	Preparatory reading assignment on AI in healthcare	*Remembering*: Being able to recognise and repeat the definition and possibilities of AI in AI-assisted monitoring	
Lesson 1.2	Class lecture: what is AI, what are its possibilities in AI-	*Remembering:* Being able to give a definition of AI, and reproduce the possibilities of AI-assisted	

	assisted monitoring?	monitoring in their profession.	
Lesson 1.3	Scenario training: simulation of practice situations	*Understanding:* Being able to read the monitor, including the predictions made by AI, indicate the differences and similarities, indicate the knowledge they do not have yet.	
Lesson 1.4	E-learning: an event takes place in the monitoring, and AI makes a prediction	*Understanding:* Being able to combine the monitoring data with the prediction made by AI, indicate what is happening and why AI makes the prediction, indicate the importance of the prediction.	One gets examples of an event and the predictions made by AI, for example a slowly changing blood pressure and the prediction that AI makes based on that. One gets questions in between, whether they understand the prediction. The anesthesia assistants gain the understanding that the measurement by AI correlates with the prediction. This could gain trust and confidence in AI among anesthesia assistants.
Lesson 1.5	Case discussion: discuss in groups/class	*Applying:* Being able to check the prediction made by AI, formulate questions, indicate boundaries and errors in procedure and treatment.	Questions are asked in between whether they can check the prediction of AI based on the data that AI has.
Lesson 1.6	Scenario training (as final validation): simulation of practice situation	*Applying:* Being able to solve a problem by using the technical devices and algorithm, choose a procedure/treatment and follow it, make a planning	

In Table 6, the second part of the module is explained. The module part 2: 'Learning about motivation and the impact of AI on motivation' allows the anesthesia assistant to gain knowledge and understanding on motivation, what motivational factors are, and which could play a role in motivation to perform patient monitoring. They gain insight in the motivational factors that are important for their own motivation, and discuss the potential impact that AI has on these motivational factors. Ultimately, they are able to estimate and check the impact of AI on their own motivation. Through this part of the educational module, anesthesia assistants are encouraged in making conscious decisions regarding their acting and behaviour in their profession, guiding them towards deliberate professionals.

Table 6. Educational module part 2: Learning about motivation and the impact of AI on motivation.

Part 1: Learning about AI	Description & Teaching form	Learning goal	Extra information
Lesson 1.1	Preparatory writing assignment on motivation. Followed by a preparatory reading assignment on motivational factors	*Remembering*: Being able to describe what is important for your personal motivation in your patient monitoring task. Being able to recognise and repeat the motivational factors that could impact the motivation in patient monitoring.	The preparatory writing assignment contains general questions about what aspects of the task are important for their personal motivation.
Lesson 1.2	Class lecture: what is motivation, what are the motivational factors that are of impact on motivation?	*Remembering:* Being able to give a definition of motivation, and retell the motivational factors that could impact motivation in patient monitoring in their profession.	The motivational factors comprise at least autonomy, relatedness, competence, self-efficacy, and self-actualisation.

Lesson 1.3	Scenario training: simulation of practice situation	*Understanding:* Being able to indicate the importance of motivation, tell in own words which motivational factors are personally important in patient monitoring, and clarify why.	The anesthesia assistant can find out which motivational factors are personally important through participation in the practice situation. The motivational factors can then also be coupled to the aspects of the task they found important in the preparatory writing assignment.
Lesson 1.4	E-learning (with room for discussion with peers) or working groups in class: Form language/drawing	*Understanding:* Being able to categorise these motivational factors by importance and mutual relations, indicate the differences, similarities, and contradictions in motivation with the use of AI-assisted monitoring.	By moving cards with the motivational factors into space one can gain insight in which motivational factors are important to them in their motivation to monitor the patient. The cards of the motivational factors that are most important are placed closer to the card called 'You'. Cards are put together if they affect each other in their motivation. Gaining insight in the interrelatedness of motivational factors is important to be able to see that impact on one motivational factor might also impact other factors indirectly. In this way, loose cards, towers, groups of cards, etcetera are possible.  The subsequent assignment is to visualise how AI affects their individual motivational factors. If it affects a certain motivational factor negatively, then that motivational factor can be blocked with a card called 'AI'. If it affects the motivational factor positively, then the card of the motivational factor is brought closer to 'You', and one can link the 'You' card with the card of the motivational factor by drawing a line and place the 'AI' on the line.  Discussion among peers is important during the assignments to gain insight in the motivation of themselves and others. Examples of relations that are identified by other anesthesia assistants may be explained by a lecturer, to help the groups on their way. For example, a relation between autonomy and relatedness may be seen as that the anesthesiologist allows you to make choices by yourself but is also always on call if needed. This way, the relations between the motivational

			factors are made specific for the profession of anesthesia assistants.
Lesson 1.5	E-learning or working groups in class:	*Applying:* Being able to formulate questions on the impact of AI on motivation, estimate the amount of impact of AI on motivation, make an overview of the positive and negative impact of AI on motivation	When discussing the impact of AI on motivation, the sensitive topic of AI takeover may be incorporated. Presenting the various types of AI-assisted monitoring to anesthesia assistants on a scale of minimal to maximal impact on their jobs helps them to consider when they see AI as positive support that may increase their motivation and when they think that AI is having a negative impact on their motivation.
Lesson 1.6	Scenario training (as final validation): simulation of practice situation, and discussion with team	*Applying:* Being able to check whether the thought impact of AI on motivation is present in a practice situation, indicate own boundaries in the impact of AI on motivation.	By checking the thought impact of AI on their motivation in the scenario training, one can see whether the different forms of AI are positively or negatively experienced in practice. This way, they can indicate their own boundaries in the impact of AI on their motivation.

9. Conclusion

This chapter contains the main findings of this study and provides answers to the sub-questions which together answer the central research question. This study aimed to identify the attitude of anesthesia assistants towards the use of AI-assisted monitoring, as well as the motivational factors important for their motivation in their task of monitoring patients and the possible effect of AI-assisted monitoring on these motivational factors. Furthermore, the goal was to develop the contours of an educational module for anesthesia assistants, regarding the subjects of AI and motivation, aiming to provide them an understanding of how AI works, as well as giving insight in their personal motivation and the potential impact of AI on motivation. This study mainly used a combination of literature research and semi-structured interviews with anesthesia assistants of the LUMC to fulfil these aims.

This research is guided by a central research question, divided into five sub-questions. In this chapter, the sub-questions are answered subsequently, which leads to the answering of the central research question.

SQ1. What characterises the working environment of anesthesia assistants and what are their tasks and responsibilities at the OR?

Anesthesia assistants work at the OR in a multidisciplinary team that comprises at least one surgeon, multiple operation assistants, an anesthesiologist, and an anesthesia assistant. Together they ensure that surgeries can take place. The OR is a complex environment due to amongst others the occurrence of unexpected events, diversity in patients, high-complex pathologies, and noise in the vital parameter measurements as well as a variety of possible causes for changings in the values of vital parameters. The job of anesthesia assistants is physically and mentally demanding, requires both technical knowledge and social skills, and includes high levels of responsibility. Also, the workload among anesthesia assistants is high, due to a shortage in staff, rise in the number of highly complex operations, increasing use of technology, and pressure to perform treatments effective, efficient, and with high levels of safety and quality.

The anesthesia during the operation is performed by the collaborative performance of the anesthesia assistant and the anesthesiologist, from induction to waking up the patient. The anesthesia assistant performs much of the monitoring of patients individually, while the anesthesiologist has the final responsibility over multiple ORs. The anesthesiologist is present in precarious situations and can be called by the anesthesia assistants in case of calamities. The anesthesia assistant monitors the values of the vital parameters of the patient continuously and medically intervenes, by giving medication, if necessary. For the monitoring of the patient, the anesthesia assistant takes more factors into account which can be summarised as the clinical perspective on the patient.

SQ2. What AI possibilities are there in the patient monitoring task of anesthesia assistants, and the prediction of risk factors?

At the moment, there is no implementation of AI-assisted monitoring at the OR yet, but much research is being performed on the possibilities to monitor the depth of anesthesia, event and risk prediction, as well as the control of anesthesia delivery. Research on the monitoring of the depth of anesthesia shows possibilities in the use of features of EEG data, as well as other clinical parameters as blood pressure and heart rate. This way, creating machine learning models that can determine the depth of anesthesia in a patient, though with varying accuracy and reliability. Regarding the event and risk prediction in monitoring, also multiple studies are performed, including research by the LUMC itself. For instance, on the prediction of hypotension, by detecting for example deviations in arterial pressure waveforms, as well as the prediction of intraoperative hypoxemia events and cardiorespiratory instability. Control systems that can automate the delivery of medication to the patient are also investigated, including the use of reinforcement learning to include feedback from the vital parameters and/or anesthesia assistant.

These studies show much potential for the use of AI in patient monitoring. However, the models have varying accuracy and reliability, and clinical feasibility is not always investigated. The implementation of AI-assisted monitoring could take on different forms, with varying levels of impact on the job of anesthesia assistants. This scope varies from AI giving suggestions, allowing anesthesia assistants to decide on accepting or rejecting the advice, to fully automated patient monitoring by AI.

SQ3. What is the perception and attitude among anesthesia assistants on AI possibilities in monitoring, and what are their preferences in the use of AI-assisted monitoring?

The eight interviewed anesthesia assistants showed little knowledge on the possibilities of using AI at the OR, and there is uncertainty and unclarity on the possibilities. However, there is quite some interest in the possibilities, although there is fear that older colleagues might not be interested as they are reluctant for changes. Because of the lack of knowledge, most have no image or expectations about AI, while some have a few ideas of applications for AI at the OR.

Their attitude towards AI-assisted monitoring is positive, as long as the predictions by AI only result in suggestions that can still be rejected by the anesthesia assistants. They still want to direct the decision making. AI should remain a supporting tool, meaning that the help in the form of extra information is valued positively as it amongst others can enable preventive actions. Only two anesthesia assistants are cautiously positive towards the possibility of AI to automate the monitoring process. Because this might mean that the anesthesia assistant can take on a multiple room responsibility like the anesthesiologist, allowing to take on other tasks. The mentioned advantages of AI-assisted monitoring are the contribution to patient safety and efficiency of the monitoring process, extra information for decision-making, and potential reduction of the workload of anesthesia assistants. Also, the anesthesia assistants generally assess the perceived usefulness of AI-assisted monitoring positively. The perceived ease of use is valued diversely as it might take time to get used to, but it might also provide rest later on by having to pay less attention, as well as might not change the monitoring task as they will still have to perform the monitoring themselves too. A concern is the chance of people losing interest or losing their ability to keep thinking and reasoning for themselves which could lead to losing sight of the patient. Especially because the computer can make a mistake as well as every patient is different and might present differently than expected. Additionally, there are environmental factors that impact the monitoring values. Also, AI is not able to include the clinical view of anesthesia assistants in its predictions and decisions, and there is always new casuistry that the AI model is not trained upon. If AI-assisted monitoring would automate the monitoring, the concerns are the abrupt changes in situations of the patient and the loss of humanity and warmth and the OR.

The behavioural intention of the anesthesia assistant to use AI-assisted monitoring is impacted by their attitude, as well as the perceived usefulness and subjective norm. The impact of the approval or disapproval of colleagues and other people of importance in the profession of anesthesia assistants varies strongly per anesthesia assistant. For some, this has no influence at all, for others, the opinion of management or anesthesiologists does matter. As the behavioural intention itself could not be measured, only a conclusion can be drawn on the perceived behavioural intention of the anesthesia assistants to the use of AI-assisted monitoring. This is predominantly positive for the form of AI-assisted monitoring where predictions are made by AI and suggestions are given, as reasoned from the positive perceived usefulness, neutrally or positive subjective norm, and mostly positive attitude towards this form of AI-assisted monitoring.

Anesthesia assistants' preferences in the use of AI-assisted monitoring are firstly that AI alerts or makes one aware of for example medication that still must be administered. Secondly, they want AI to play a role in the calculation of medication amounts that must be administered. Thirdly, it should integrate multiple values of vital parameters as well as incorporate information on the surgery into its predictions. Fourthly, AI should predict values of parameters that cannot be measured directly. Furthermore, improvements by AI in devices like the BIS-monitor as well as the pulse oximeter and ventilation machine are wishes of the anesthesia assistants.

SQ4. How could the use of the AI possibilities affect the anesthesia assistants' motivation in their task of patient monitoring?

The motivational factors of autonomy, relatedness, competence, self-efficacy, and self-actualisation are all found important to very important for the motivation of anesthesia assistants in their task of patient monitoring. Which motivational factors are most important differs per anesthesia assistant, as well as which factors they see as interrelated. Various specific forms of interrelatedness between all motivational factors are identified, with sometimes varying as well as comparable substantiations by the anesthesia assistants. For example, interrelatedness between autonomy and relatedness is identified as the anesthesiologist allows you to make choices by yourself but is also always on call if needed. And between competence and self-efficacy, because if you know what you are doing, you feel competent, meaning that you also belief in yourself. The interrelatedness between the factors means that if one of the factors is influenced, other motivational factors may indirectly be influenced as well. This is a critical point of attention to consider for the potential impact of the use of AI on their motivation.

The impact they imagine that AI might have on their motivational factors varies from negative to positive and depends on the form of AI-assisted monitoring. AI-assisted monitoring in the form of suggestions would for some of the anesthesia assistants have no impact on their motivational factors, while others fear that their intrinsic motivation as amongst others their relatedness with their task will decrease. One anesthesia assistant thinks that competence as well as autonomy may increase as AI could provide information that assists in making the right decisions. If AI would also automate the medication administering to the patient, concerns are the loss of autonomy, relatedness with the team and task, and competencies. However, there is also the thought that it would enable one to perform other tasks in the meantime, which influences the motivation positively. And if the anesthesia assistant would perform the monitoring on a distance, in a room with cameras, the impact on the motivational factors could take on different forms. Being all alone in there would decrease their relatedness, but if they were there with other colleagues it would increase relatedness. Likewise, if the anesthesia assistant can only check AI, the autonomy and competencies are compromised, but autonomy and competence may expand if it allows them to perform other tasks.

SQ5. How can the knowledge on attitude and motivation of anesthesia assistants be used to build an educational module to support anesthesia assistants in their awareness and understanding of the impact of AI in their monitoring task?

The lack of knowledge on the possibilities of AI-assisted monitoring among anesthesia assistants, as well as their interest in learning more about AI and their motivation resulted in the development of the contours of an educational module about AI and motivation. Their knowledge on and attitude towards the different forms of AI-assisted monitoring is taken into consideration for the set-up of this educational module, as this also may impact their motivation to participate in the educational module. Their positive attitude towards the form of AI-assisted monitoring making predictions and giving suggestions is taken as foundation for this educational module, as more automated forms of AI-assisted monitoring are valued less positively. Furthermore, their design requirements for the educational module as well as the design requirements gained during the expert validation by an educator of anesthesia assistants are used for its set-up. Also, the results on the motivational factors are used in the educational module. Not with the aim of motivating the anesthesia assistants to use AI, but rather to provide insight in which motivational factors are important in their motivation, and the impact of AI on these factors. This insight is important for their development towards deliberate professionals, as their motivation influences their professional behaviour. Similarly, the findings that there are various thoughts as well as uncertainties on the impact of AI on the motivational factors, resulted in the inclusion of lessons on the impact of AI on motivation. Gaining insight on the impact of AI on their motivation allows them to deliberately make decisions in how to work with AI-assisted monitoring.

The educational module consists of two parts. One part regarding AI-assisted monitoring, to enable anesthesia assistants to learn about what AI entails, what the possibilities in AI-assisted monitoring are, and to enable them to understand and use the predictions that AI makes in monitoring. The second part, regarding motivation and the impact of AI on motivation, is meant to enable them to learn about the motivational factors that are important for their motivation in monitoring. And to enable them to estimate and check the amount of impact they think AI-assisted monitoring will have on their motivational factors. This way, it supports them in their awareness and understanding of the impact of AI in their monitoring task. Moreover, by sharing this information with colleagues, insights on how to deal with AI-assisted monitoring in such way that your motivation can stay intact or even increase are shared with each other.

RQ: "How can knowledge on the attitude of anesthesia assistants towards Artificial Intelligence (AI) and their motivation in their task of patient monitoring in the Operating Room (OR) be used to build an educational module that could support anesthesia assistants in their awareness and understanding of the impact of AI-assisted monitoring?"

From this study it appears that there is a lack of knowledge on AI-assisted monitoring among anesthesia assistants. At the same time, their attitude towards AI-assisted monitoring is quite positive, on the condition that AI does not take over the decision-making but only gives suggestions. Furthermore, this study shows that the motivational factors of autonomy, relatedness, competence, self-efficacy, and self-actualisation are important to very important for the motivation of anesthesia assistants in their task of patient monitoring. The impact that AI-assisted monitoring may have on these motivational factors is reasoned variedly by the anesthesia assistants, varying from positively to neutrally to negatively, and depends on the form of AI-assisted monitoring. This study shows that specific forms of interrelatedness between the motivational factors are present for their motivation in patient monitoring. Hence, the impact of AI-assisted monitoring on one

motivational factor also impacts other motivational factors in the motivation of anesthesia assistants. Because their motivation influences their professional behaviour, and as their professional decision-making is directly related to patient safety, giving anesthesia assistants insight into their own motivation as well as into the impact of AI on their motivation is important to guide them to become deliberate professionals. These research findings are therefore used for the development of an educational module about AI, motivation, and the impact of AI on motivation, for anesthesia assistants. This way, anesthesia assistants can develop awareness and understanding of how AI-assisted monitoring, in the form of giving suggestions, can support them in their patient monitoring task. And, develop awareness and understanding on their own motivation and the impact that the use of AI-assisted monitoring may have on their motivation.

10. Discussion and recommendations

This chapter comprises the discussion on the whole research. Section 10.1 discusses the restrictions of the theoretical framework. Section 10.2 discusses the methodology. In Section 10.3 and 10.4, respectively the results of the study and the educational module are discussed. Finally, in Section 10.5 the added value of this research is elaborated upon.

This study aimed to contribute to the identifying of the attitude of anesthesia assistants towards the use of AI, as well as the identifying which motivational factors are important for their motivation in patient monitoring, and the possible effect of AI-assisted monitoring on these motivational factors. Additionally, this study aimed to develop the contours of an educational module on the topics of AI and motivation for anesthesia assistants.

By discussing these topics with anesthesia assistants through semi-structured interviews, their attitude towards the different forms of AI-assisted monitoring, as well as their preferences and concerns were investigated. This contributes to solving the discussed problem of insufficient knowledge about the needs and preferences of the anesthesia assistants as users of AI. Furthermore, the motivational factors that are important are identified through a combination of literature research and semi-structured interviews with anesthesia assistants. The prospect on the impact of the different forms of AI-assisted monitoring on these motivational factors is also explored among the anesthesia assistants. Though, a real investigation on the attitude of the anesthesia assistants, as well as on the impact of AI-assisted monitoring on their motivation, is only possible during actual implementation in the future. The more extensive problem of lack of incorporation of the users in the development and clinical implementation of AI at the OR is not fully solved by this research. However, the design of the contours of an educational module on the topics of AI and motivation, including learning goals, is successfully executed. This educational module aims to contribute towards a more thorough awareness and understanding of AI and its possibilities, the motivation of anesthesia assistants, and the impact of AI on their motivation, among anesthesia assistants, which could be part of the solution to this more extensive problem. However, although expert validation by an educator of anesthesia assistants was performed, further development and validation of the module in practice are still required.

10.1. Restrictions of the Theoretical Framework

The theoretical framework of this study aimed to provide a theoretical basis for both the research on the attitude and motivation of anesthesia assistants, and the educational module. Discussion points on this theoretical framework are described in this section.

Additional theoretical substantiation required

In this study, the perception of the anesthesia assistants on AI was investigated, using the indicators of knowledge, interest, and expectation. However, this part of the research was not supported by theory in the theoretical framework, as no theory was found that could describe the perception in this context. Consequently, it was not supported that knowledge, interest, and expectation were real indicators of perception. The definition of perception in the research of Karim et al. (2011), interfaces with the definition of perception in this study. According to this article, the perception of the perceiver is influenced by factors in the situation, factors in the target, and factors in the perceiver. The factors in the perceiver comprise interest, attitude, motives, experience and expectation (Karim et al., 2011). However, a theory that would fully match the definition of perception of this study would support this study more strongly. Or maybe other indicators should have been chosen to define and research the perception on AI-assisted monitoring by the anesthesia assistants.

The definition of the motivational factor relatedness is split up into relatedness with colleagues and the team, and relatedness with the task one is performing. For the latter, no theoretical substantiation was found. However, the relatedness to the task is still considered important as addition to the definition of relatedness in this context, as the anesthesia assistant mostly performs the monitoring task individually. Hence, the indirect relatedness with the patient might also impact the motivational factor of relatedness, because anesthesia assistants feel responsible to perform this task as optimal as possible to enable good care for the patient. This is also affirmed by some of the anesthesia assistants. However, a good theoretical substantiation for the incorporation of relatedness to the task would provide a theoretical foundation for this study and is therefore a recommendation for future research.

Limitations of the Technology Acceptance Model for this study

For the theoretical substantiation of the attitude of anesthesia assistants towards the use of AI-assisted monitoring, the Technology Acceptance Model was used. As described earlier, AI is not a simple and fixed technology, as it will adapt over time based on continuous new data and feedback that it may incorporate in its model. The Technology Acceptance Model is developed before AI was developed. Consequently, this model is inadequate to fully define and research the attitude of the anesthesia assistants. However, by using amongst others the research by Charness & Boot (2016), different theories and models of technology adoption and acceptance were compared (Charness & Boot, 2016). And as there is no specific model yet on attitude, behavioural intention, or acceptance of AI, this model provided the best theoretical support as possible. As AI is increasingly used in society, a new model on the acceptance of AI should be developed. This model could for example also include uncertainty in use, due to the continuous changing and adaptation of the AI technology over time. Future research could then use this model as theoretical basis for the identification of the attitude, behavioural intention, or acceptance of AI by users.

Furthermore, the Technology Acceptance Model is not specifically adapted to a health care context, as was also described in research by Holden & Karsh (2010) on the application of the Technology Acceptance Model in researching acceptance of health information technology (Holden & Karsh, 2010). They suggest adding new variables and relationships to improve this model.

Selection of theories for motivation and definitions of variables

Regarding the motivation, for the theoretical substantiation of the motivational model multiple theories on motivation were used. Namely, the Self-determination theory, Self-efficacy theory, and the Expectancy-value theory. These theories were mainly chosen due to their match with the context of intrinsic motivated behaviour of an individual to perform a task.

However, the Expectancy-value theory is not described as one clear theory in literature and different studies use the theories in different ways adapted to the research context. For that reason, the theory is not always applicable in the same way. The used description of this theory by Studer & Knecht (2016) offers guidance in this study but might not provide the strongest theoretical substantiation. Furthermore, as the four psychological actions that may impact self-efficacy are not clearly defined in the theory, different definitions are used in different studies. The definitions for verbal persuasion, performance accomplishment, vicarious experiences, and physiological arousal, are thus chosen based on the context as well as the definitions given in the research by Hoffart (2002) (Hoffart, 2002). However, it should be kept in mind that different definitions for all these variables could have been chosen, which could have caused the results in this study to be different.

In the same way, the definitions for the other motivational factors were based on interpretation as well, meaning that different definitions could have been chosen for all motivational factors. Also here, this could have led to different outcomes. For example, self-actualisation is defined as development and fulfilment of the talents and potential by learning new things and learning from others. However, this factor could also be defined as actualisation of things you already know, and whether one can mobilise this knowledge. As the source that is used as theoretical basis determines the definition of the motivational factor, the effort was to base the definition as much as possible on the original theory. However, it was not always possible to fully extract all needed information from the original theory.

Another point of discussion could be the choice to define the factors that influence expectancy and value in the Expectancy-value theory as separate variables, instead of choosing expectancy and value as variables. From the first interview with AM0, it appeared that the factors of expectancy and value were so vague that these were not understood. Furthermore, it was estimated that the factors that impact expectancy and value had such an impact on motivation that they were on an equal footing with the other motivational factors. From the research on the importance of the motivational factors for the motivation of anesthesia assistants, it was confirmed that these factors were not valued as less important. However, further research could provide an answer on whether the factors of expectancy and value could provide a better fit in a motivational model that describes the motivation of anesthesia assistants in their monitoring task.

Other motivational theories could also have been chosen as replacement for the theories, or as additional theory, to develop this motivational model, as the Maslow's Hierarchy of Needs model. This model describes the five categories of physical needs that someone requires to be motivated. The needs are arranged in a hierarchical order in a pyramid, see Figure 14. Meaning that if the lowest need is met, the following, higher, need emerges (Maslow, 1943). The lowest two order needs are the basic needs and comprise physiological needs, as food, and safety needs, as security and safety. The third and fourth order needs comprise psychological needs. The third order includes belonginess and love needs and includes needs like friendships and a sense of connection. The fourth order includes esteem needs, such as confidence, freedom,

recognition by others, and feeling of accomplishment. The fifth, and final, order needs comprise the self-fulfilment need of self-actualisation, meaning the need for development or the achievement of the full potential of oneself (Maslow, 1943). However, also this model would need certain adaptation before completely matching the context of this study. As for example the basic needs of the two lowest order needs are not directly related to the monitoring task. The rest of the categories of this model overlap with the motivational model as described in this study, and with that provide some support to the motivational model.

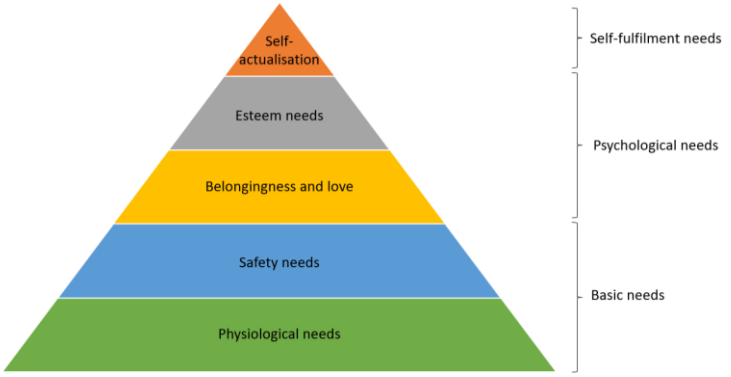


Figure 14. Maslow's Hierarchy of Needs model. (Own visualisation, adapted from Maslow's Hierarchy of Needs model by Maslow (1943) (Maslow, 1943)).

10.2. Method selection: reliability, validity, and ethics

The methodology of this study aimed to substantiate the set-up of this research as well as the decisions that were made in choosing certain methods. This section discusses the choices made in the methodology.

Reliability

An explorative, qualitative research was chosen as it allowed for freedom in choosing the direction of the study based on the findings during the exploration of the field, as well as to dive deeper into the thoughts and believes of anesthesia assistants. Quantitative research, for example by using a survey, would have allowed for a bigger sample size, which would be valuable for this study by gaining a lot of different thoughts and opinions on their attitude and motivation. Furthermore, it would enable a higher degree of generalisability of the research results. The reliability of this study is thus limited by a lower sample size, as a result of the choice for qualitative research through interviews. However, the subject of AI as well as motivational factors was mostly new as well as complex to anesthesia assistants. Meaning that good explanation of the subject and questions was required, also to ensure that the questions were interpretated correctly. This is made possible by performing qualitative research through interviews. Also, it allowed to ask follow-up questions as well as find nuances in their answers, enabling to really find out what amongst others their attitude is towards the different forms of AI. Using semi-structured interviews allowed for collection of information on the different subjects, as well as letting anesthesia assistants add extra points that they find important in the subject.

By using design-based research, the study not only resulted in an overview of the attitude of anesthesia assistants towards AI, their motivation and thought impact of AI on this motivation. It also allowed to elaborate the collected information into the design of a valuable solution for anesthesia assistants, namely the educational module about AI and motivation.

The semi-structured interviews were performed with eight anesthesia assistants of the LUMC hospital. According to research by Guest, Bunce & Johnson (2006), saturation, so the point at which the resulting data of interviews contains no new themes or information, is reached within the first 12 performed interviews. However, already as early as six interviews, the basic elements of the questioned subjects can be identified (Guest, Bunce & Johnson, 2006). This means, that this saturation point may not yet be reached in this study, and this sample size does not allow for a high degree of generalisability of the results. However, the basic elements around attitude and motivation are probably discovered within this study, allowing for the exploration of these subjects. A recommendation would be to increase the number of interviews in future research on this subject, to ensure that the saturation point is reached.

A point of attention must always be the possibility of sample bias. Diversity in the interviewed anesthesia assistants is reached by interviewing both males and females, with varying ages and experience. The latter means that both anesthesia assistants that are working in the field for up to five to ten years and anesthesia assistants of more than 30 years of experience were interviewed. However, the collection method for finding interviewees was via a message in the newsletter. This means that only anesthesia assistants have

responded that were interested in study participation. This could mean that only those that are already interested in AI respond, as these are wanting to learn more about it. On the other hand, it may also be the case that those who are more negative towards AI respond, as these would like their voices to be heard. Both may have resulted in a non-representative sampling. A possible sample bias can have impacted the results on their attitude towards AI. As some of the anesthesia assistants indicated that they thought that some of their colleagues would be more negative towards AI as they are themselves, a sample bias towards a slightly more positive attitude must be kept in mind.

Validity

A valid data collection was endeavoured to be obtained by continuously using a combination of literature and interviews. The literature research on the target group of anesthesia assistants and their tasks and responsibilities, on the technical possibilities of AI in monitoring and predicting risk factors, and on the motivational factors are all checked and supplemented by interviews with anesthesia assistants as well as conversations with anesthesiologists and researchers active in the field of AI for healthcare. Moreover, the motivational model that is set up by the information found in literature research and checked and adjusted through the first couple of interviews with anesthesia assistants, is also tested in the subsequent interviews with anesthesia assistants. Aiming at using the target group of anesthesia assistants to find out which motivational factors of the final model are of most importance for their task-related motivation as well as to identify the relations between the factors. Furthermore, literature research formed the theoretical basis for the educational module, after which both the literature used for the module as well as the set-up and learning goals of the module were checked and complemented through expert validation with an educator of anesthesia assistants.

The interview protocols for the semi-structured interviews with the anesthesia assistants were not kept constant, by using the information of previous interviews to slightly adapt the questions of the subsequent interviews. This was done to refine questions, or make them more easily understandable, as well as add some extra questions on their tasks and devices used in monitoring, perception and attitude, preferences and concerns, and regarding their education and the educational module. Adapting the interview protocols has its benefits and downsides. The downside is the limited generalisability of the answers due to diversity in the questioning. However, allowing earlier input to sharpen research questions has the benefit of creating an increased emphasis in the study. As the questions connect better to their thoughts and feelings, this will result in more focus in the answers of the anesthesia assistants. Also, points of attention discussed by anesthesia assistants may also be essential to the other anesthesia assistants, which the interviewer was unaware of prior to the interview.

Ethics

This research was conducted according to the principles of the Declaration of Helsinki (World Medical Association, 2013). Participants were not exposed to any risks or harm in this study. While this research may not include vulnerable groups it may involve sensitive data regarding the opinions of anesthesia assistants of the LUMC towards their tasks and job. For that reason, the questions used in the interviews with the anesthesia assistants were carefully considered by the interviewer because one must be aware of the context of a hospital where not everything can be questioned. Furthermore, the results of the interviews were anonymised, and it was ensured that the answers do not include identifying information to prevent that these answers can be led back to individual persons. Responsible management of the research data, including the safe storage of the data, is important and followed TU Delft guidelines. Furthermore, interviewees were asked to provide their informed consent prior to the interviews as well as an introduction to the research, and the purpose of the interviews, was sent to the participants on beforehand. Participation in the study was on a voluntarily basis and without any further consequences.

General recommendations on methodology

General recommendations for a potential future repetition of this study would be to perform the research with a bigger sample size, in which also people that do not respond by themselves are included to filter the possible bias in sampling. Furthermore, using a constant interview protocol, as the final questions can now be extracted from the interview protocols and re-used in future research, to ensure that the highest degree of generalisability of the answers can be reached. It would also be interesting to perform the research in both an academic hospital and a peripheral hospital to be able to find out whether there are any differences in perception, attitude, and motivation. Likewise, performing this research on other medical support staff outside of the OR, as on the Intensive Care Unit in which also patient monitoring takes place, would be interesting.

10.3. Implications of and elaboration on the results

Results on the topic of perception, attitude, and motivation were gained by slightly adapting the interview protocol based on the answers of the first few interviews with anesthesia assistants. This allowed to gain a clear direction, and in-depth answers could be acquired. The results on these subjects are discussed in this section.

Perception
Regarding perception, it resulted from the interviews that there is a lack of knowledge on the possibilities of AI within the OR among anesthesia assistants. The shortage in knowledge and understanding on AI by clinicians, which prevents collaboration and knowledge exchange between clinicians and engineers, was also identified by Olczak et al. (2021) (Olczak et al., 2021). Also, in the communication with one of the experts in the field of AI in healthcare, it was indicated that clinicians do not know what the value of AI can be in the healthcare field. This has to do with the abstractness of AI. If the possibilities would be made more clearly visible for clinicians, the applications that would be useful for them would naturally emerge (T. Vijfvinkel, PhD candidate TU Delft, personal communications, January 13, 2022). This unawareness of the true possibilities of AI in healthcare prevents them from thinking along and providing input on the development of AI (Kelly et al., 2019). According to Hashimoto et al. (2020), understanding of the AI technology applications, and how these can be used to provide safer, more efficient, and more cost-effective care for patients, is critical for clinicians in all disciplines (Hashimoto et al., 2020). Taking away certain objections among clinicians, by informing them as well as allowing them to think and discuss their thoughts and concerns, will be the first step for implementation in hospitals. This way, a balance could be found between a technology push and connecting the development of AI applications on the right clinical demand (T. Vijfvinkel, PhD candidate TU Delft, personal communications, January 13, 2022).

Attitude
Regarding attitude it became clear that the anesthesia assistants' attitude is now based on a limited knowledge of AI, and for some this is even limited to the information received by participating in the interviews. Right now, their attitude towards AI-assisted monitoring is positive, under the conditions that AI-assisted monitoring only gives suggestions as they would still want to be involved in the decision-making. As this attitude is mostly based on the information received in this study, it would be intriguing to find out what their attitude towards AI-assisted monitoring is when AI would be in use at the OR. Likewise, due to the impact of the lack of knowledge on both the perception and the attitude, the impact of the educational module on the perception and attitude of the anesthesia assistants on AI-assisted monitoring is interesting to investigate.

One of the main concerns that emerged from the interviews was the absence of the integration of a clinical perspective into AI-assisted monitoring. This is indicated by them as even more important than the values of the vital parameters on the monitor. This conforms with the research by De Wildt et al. (2007), Murphy et al. (2010), Aggarwal et al. (2010), and Robert (2019) that technology can provide support for clinicians at the OR, but is unable to replace them (De Wildt et al., 2007; Murphy et al., 2010; Aggarwal et al., 2010; Robert, 2019). The importance of the clinical perspective as well as the thought that AI will improve healthcare but will never take over the whole profession, is also affirmed by the interview with the anesthesiologist and the conversations with Vijfvinkel and Jessen (Interview AL1; T. Vijfvinkel, PhD candidate TU Delft, personal communications, January 13, 2022; H. Jessen, MSc Artificial Intelligence, personal communications, November 24, 2021). According to Vijfvinkel, patient representations are too different per person, meaning that too many factors must be incorporated for a computer (T. Vijfvinkel, PhD candidate TU Delft, personal communications, January 13, 2022). The complexity of the high amount of disturbances in the measurements is also mentioned as argument for this by the interviewed anesthesiologist (Interview AL1). Also, the caring and empathy of anesthesia assistants cannot simply be taken over by computers (Aggarwal et al., 2010; T. Vijfvinkel, PhD candidate TU Delft, personal communications, January 13, 2022).

One other mentioned concern in the use of AI-assisted monitoring is the decrease in self-thinking among anesthesia assistants due to the use of AI-assisted monitoring. It is interesting to find out what the real impact of AI-assisted monitoring on the self-thinking of anesthesia assistants is. So, whether the anesthesia assistants simply apply the predictions and suggestions in practice or check them for themselves, and whether this leads to less or more self-thinking.

Additionally, a concern among the anesthesia assistants is the medical responsibility when something goes wrong with the patient. As right now the anesthesia assistant, together with the anesthesiologist, has the

responsibility for the patient, also if they use technology in their decision-making (Asan, Bayrak & Choudhury, 2020). However, AI is not a simple technology that is directly comparable to other technologies that are in use in the OR. If the AI-assisted monitoring provides incorrect predictions and suggestions, the question will be whether the anesthesia assistants will keep the full responsibility if they make the decision based on the suggestion (Neri et al., 2020). And if AI-assisted monitoring will even be more automated, and the anesthesia assistant is present to check the decisions made by AI, the question is even more urgent. The amount of responsibility will impact the trust of anesthesia assistants in AI-assisted monitoring. They might not want to trust the predictions of an algorithm if they remain fully responsible. If these healthcare professionals would be better informed about AI and its risks, they will be able to make better deliberations on the responsibilities they want to keep or drop out. The subject of the autonomy of the anesthesia assistant is related to this, as giving away responsibilities is connected to autonomy, which may impact their motivation. Barriers for AI implementation, thus the discussed legal responsibility but also other barriers such as costs, and ethical barriers like privacy, data-sharing, and explainability, are not part of this study. However, before clinical implementation, and with that the use, of AI-assisted monitoring may take place, these barriers must be identified in detail as well as discussed with all stakeholders who are involved (Park et al., 2020). Various concerns and risks connected to the use of AI in healthcare are of major importance (Schönberger, 2019). It is therefore recommended that further research on these topics will be performed parallel with the further development of AI-assisted monitoring.

All in all, it seems to be important to incorporate the anesthesia assistants early in the development of AI for their profession. This study aims to contribute to this. Early discussion on the preconditions of medical staff to use AI is important for the eventual implementation, as these are the people that will work with it in their job day in day out. What they trust, or do not trust, is a key requirement (T. Vijfvinkel, PhD candidate TU Delft, personal communications, January 13, 2022).

Behavioural intention

The behavioural intention was not measurable, as AI-assisted monitoring is not applicated in the OR yet. But it was estimated based on the analysis of the attitude of the anesthesia assistants as well as by including the measured perceived usefulness and subjective norm. The finding that the behavioural intention is predominantly positive for AI-assisted monitoring in the form of giving suggestions is thus only an estimation.

Behavioural intention is also often referred to as acceptance in various studies, according to Holden & Karsh (2010) (Holden & Karsh, 2010). Lack of acceptance is the most prominent reason for non-adoption and is consequently a barrier to successfully implement AI (Strohm et al., 2020). Anesthesia assistants' acceptance of AI is crucial for the further development of AI for the OR. Also, the concerns of anesthesia assistants towards the use of AI should be important knowledge for AI developers during the development process (Taherdoost, 2018; Mathieson, 1991). Further research on the behavioural intention and behaviour of anesthesia assistants in the use of AI-assisted monitoring should be performed when AI-assisted monitoring is implemented at the OR, to identify the real behavioural intention of anesthesia assistants. With that, a more successful implementation that is in line with the requirements of anesthesia assistants lies in plain view.

Motivation

For the research on motivation, some restrictions can be identified, of which one was not mentioned yet in the methodological restrictions. Namely, the motivational factors were asked in the context of the task of patient monitoring. However, sometimes it seemed that the anesthesia assistants broaden this context to their full profession. This could have affected their answers regarding the motivational factors. On the other hand, the monitoring task is a major part of their profession, as well as AI-assisted monitoring will also impact the tasks surrounding the monitoring, decreasing the potential impact of the interpretation differences on the results.

Because the motivational factors that were identified in the literature research were all scaled as being important to very important for the motivation of anesthesia assistants, it is confirmed that these motivational factors belong in the motivational model of the literature research. No extra motivational factors were added by the anesthesia assistants to this model, although this could have been affected by the set-up of the interview questions. However, some extra points were mentioned that were important for their motivation. These points may partly be summarised into relatedness to the task and patient, autonomy, and extrinsic motivational factors. But some other subjects like being trendwatchers, the correlations between the changings of the vital parameters, the diversity of the tasks in the job, the combination of social and technical skills, and the tension and unexpectedness in the profession, might all be part of other factors that have not been included in this motivational model. Further research on whether some of these may be described in the form of another motivational factor, or factors, is needed to create a motivational model that fully describes

the motivation of anesthesia assistants in their monitoring task. Additionally, verification of the presumed irrelevance of the factors that were now kept outside of the circle, and thus not included in the final theoretical model, could also have been performed among the anesthesia assistants. Further research on the relevance of these factors is suggested. Furthermore, investigation on whether this model can be extended into the full job of anesthesia assistants, or to other medical support staff professions, or anesthesiologists, is valuable to extend the generalisability of the motivational model.

The motivational factors were also ranked on importance for their motivation by the anesthesia assistants, resulting in varying ranking orders. None of these factors stood out in highest or lowest order ranking, and no correlation was identified between the amount of experience or gender of the anesthesia assistants and the ranking order. As the sample size is low, no real quantitative analysis is possible on these results. The only thing that can be concluded from this part of the study is that all these motivational factors are important for the motivation of anesthesia assistants in their task of patient monitoring.

Also which relations were identified between the motivational factors, and why, varied strongly between the anesthesia assistants. The relations identified in literature between the motivational factors were expected to be true for the motivation of anesthesia assistants. Specific substantiations for relations between motivational factors for their working context were found. However, not all relations were confirmed by all anesthesia assistants for their specific working context. Furthermore, reasoning for conformation or disapproval of the relations was at times deviating or even contradictory. However, it should be kept in mind that differences in definitions, and interpretations of these definitions, of the motivational factors could play a role in the match or mismatch of identified relations by literature and anesthesia assistants as well as among anesthesia assistants. More literature research could be performed to confirm or refute the relations found in practice, as well as expanding the research among anesthesia assistants could result in finding out whether these relations are really present between the motivational factors. All in all, the fact that relations between all motivational factors were identified means that the factors cannot completely be seen as separate. If one of these factors is positively or negatively impacted, this will also impact other related motivational factors. Hence, the totality of factors must be looked into when the impact of AI on these motivational factors is investigated.

Impact of AI on motivation

On the prospect on the impact of AI of these motivational factors, no general conclusion can be drawn, as the answers of anesthesia assistants varied per form of AI-assisted monitoring as well as per anesthesia assistant. Both positive and negative influences of AI on motivation are possible. As can be concluded from this study, relations are present between the motivational factors. Meaning that impact on one of the motivational factors can also have impact on the other related motivational factors. The negative or positive impact of AI on the motivational factors is strongly dependent on the form that AI-assisted monitoring will take, according to the anesthesia assistants. The worries of the possible negative impact of AI on motivation are higher when a more automated form of AI will be used, but is also seen as a possibility to perform other tasks in the meantime which could have a positive effect on motivation. As AI is not applicated yet, it is hard for anesthesia assistants to indicate what the effect of AI on motivation will be. Once AI is implemented at the OR, future research can perform a real investigation on the impact of AI-assisted monitoring on their motivation. Continuing research is also important because AI is a non-firm technology that will adapt, based on new data and input over time. A learning process for the use of AI by the anesthesia assistant will take place, which may differ from the learning process on simpler technology. That way, the impact of AI on their motivation may be dependent on where they are in the learning process as well as how AI has adapted to its environment over time.

Perspectives of other stakeholders

The motivation of anesthesia assistants thus appears to be an important point of view to describe the complex problem of using AI-assisted monitoring in anesthesia at the OR, as their motivation is important for them, and the worries on negative impacts of AI on motivation are present. Additionally, also other points of view, as the anesthesiologists, but also the patient, the hospital, AI-developers, the ministry of health, or healthcare payers are important to identify the impact of the use of AI-assisted monitoring on all involved stakeholders. A form of AI that matches with the motivation of anesthesia assistants, but not of anesthesiologists, may lead to a clash in their collaboration. Likewise, the ministry of health or healthcare payers may want a fully automated form AI-assisted monitoring to reduce the costs of personnel, but as this may heavily impact the motivation of the personnel that is left this may also not be the best option. To find the best way of implementing AI-assisted monitoring in the future, the perspectives of all stakeholders should be explored.

10.4. Educational module: strengths and further requirements

The second aim of this study was to use the findings on attitude and motivation to develop the contours of an educational module for anesthesia assistants on the topic of AI as well as the topic of motivation and the impact of AI on motivation. With that, aiming to support them in their awareness and understanding of how AI works, their motivation, and the possible impact of AI-assisted monitoring on their motivation. This section discusses the educational module that was built as solution to support anesthesia assistants.

Strengths: inclusion of design requirements and results on perception, attitude, and motivation
The set-up of the educational module, including the learning goals, is performed in line with the educational programme of anesthesia assistants in the LUMC to best match with their education. Likewise, the educational module is tried to best match the interest and preferences of anesthesia assistants in learning. Firstly, by asking their design requirements for an educational module on AI and motivation in the semi-structured interviews and using these to build the educational module. Secondly, by using the results on perception, attitude, and motivation as basis for the educational module. As it became clear that the knowledge on AI is very limited among anesthesia assistants, this was used as the base line of knowledge that a student needs to have to be able to start with the module. Likewise, the level of knowledge on the motivational factors was used as baseline in the module. The attitude of the anesthesia assistants towards AI-assisted monitoring appeared to be quite positive, as long as AI would only give suggestions. To match their attitude towards AI, the form of AI-assisted monitoring in this module only gives suggestions, and is thus not the fully automated variant. Moreover, the motivational factors of the theoretical motivational model, which were affirmed to be important for the motivation of anesthesia assistants, were incorporated in the part of the module about motivation. As one motivational factor may also directly impact other motivational factors, also something about these relations is included in the module to give anesthesia assistants insight in the interrelatedness of these factors. As the impact of AI on the motivational factors may vary dependent on the form of AI-assisted monitoring and per person, as well as the impact of AI is still unclear, the educational module teaches anesthesia assistants to think about the impact of AI on motivation for themselves and check in practice whether this impact really takes place.

Strengths: unique form of educational module and addition to careful implementation of AI
Many other options for educational modules would have been possible. For example, with the results of this study on motivation, also an educational module that motivates anesthesia assistants in their monitoring task, or motivates anesthesia assistants to use AI, would be possible. By focusing on giving anesthesia assistants insight in their own motivation, instead of only focusing on learning content, a unique form of an educational module is built.

This educational module enables the anesthesia assistants to cooperatively learn to understand what AI entails, how they relate to the technology, and what it could mean to them in their task of patient monitoring. This is a first step for careful implementation of AI in practice in healthcare. It is recommended that this careful implementation continues, for example by using guidance ethics. In guidance ethics, all stakeholders that are involved in the use and development of AI for at the OR discuss together how the technology can be rightly introduced such that it is used responsibly and will add something to the practice in which the technology is used. Considering all values of all stakeholders that are at risk, such as health, well-being, trust, and reliability (A. Krom, researcher on guidance ethics at the LUMC, personal communications, March 1, 2022).

Further development and validation in practice
As both design requirements of anesthesia assistants and those of an expert, an educator of anesthesia assistants, were used, and an expert validation of a draft version of the module was performed, the educational module was developed as far as possible within this study. However, the educational module still needs to be worked out further. It must also be tested in practice to find out whether it really contributes to the awareness and understanding of the anesthesia assistants on the impact of AI-assisted monitoring in their task of patient monitoring. This way, the validity of the educational module could be really tested. Validation could take place by enabling the users to fulfil the educational module at their own pace, and asking for feedback among the users. Amongst others on whether the educational module provided the right information on what they need for working in practice, how it matched with their knowledge, whether the difficulty level was built up properly, whether it matched their interests, and whether they were motivated to participate in the module.

10.5. Relevance of this study

This study aimed to contribute to the identifying of the attitude of anesthesia assistants towards the use of AI, their preferences in the possibilities of AI in monitoring, which motivational factors are important for them in their monitoring task, and the possible effect of AI-assisted monitoring on these motivational factors. With that, this study aimed to contribute both scientifically and socially. The scientific and social relevance of this study are discussed in this section.

Scientific relevance
By coupling the theory on attitude and behavioural intention, as well as on motivation, to practice research in this study, a contribution is made to the investigation of attitude and behavioural intention towards the use of AI-assisted monitoring, and the investigation of the motivation and the impact of AI on the motivation of anesthesia assistants.

Although this study does not investigate the transdisciplinary learning between anesthesia assistants and AI developers itself, it does contribute to the transdisciplinary learning process. Transdisciplinary scientific collaboration requires substantial preparation. The effectiveness of the collaboration can be increased by improving the preparation by bringing information from anesthesia assistants to AI developers and from AI developers to anesthesia assistants (Stokols et al., 2008). Good communication between the anesthesia assistants and the professionals that are engaged in the development, introduction, and use of the technology in healthcare is essential for a smooth introduction of the technology (Nederlandse Vereniging van Anesthesiemedewerkers, 2014). By identifying the perception and attitude of anesthesia assistants towards AI-assisted monitoring, as well as the motivational factors that are important, valuable information is collected for AI developers, as well as for anesthesia assistants themselves. AI developers can use this information to determine the requirements for AI and incorporate those in the further development and implementation of AI-assisted monitoring in healthcare. Early incorporation of the end user is essential for AI development (Robert, 2019). For anesthesia assistants this means that eventually their motivation will be included in the development of new applications for in their work. Additionally, the overview of the motivational factors might also be used for other improvements in healthcare. Amongst others, by managers that have to create a working environment with AI for their employees, for whom such an overview may provide support.

Additionally, this study contributes to this collaboration by bringing information about AI, the possibilities of AI within patient monitoring, and how AI-assisted monitoring could provide support in the monitoring task, from the AI developers towards the anesthesia assistants by setting up the contours for an educational module in the anesthesia assistants' education. Information about the possibilities and risks of AI in anesthesia is important for anesthesia assistants to develop knowledge about AI and be able to think along with AI developers. Also, expectation management about AI is important to prevent deception and make the anesthesia assistants aware of the benefits of AI for them.

With this contribution to the transdisciplinary scientific collaboration process, focusing on the transdisciplinary learning process, also a contribution is made to the research on transdisciplinary learning of the Department of Science Education and Communication of the TU Delft.

Furthermore, with this study, more insight is gained on how motivation of professionals in a complex environment can develop by for example the use of a complex technology as AI. This insight could also be incorporated into the development and implementation of AI.

The study on the impact of AI not only contributes to the anesthesia assistants, but indirectly also to other members of the multidisciplinary OR team as there is continuous collaboration and alignment with the anesthesiologist and surgeon. If the AI development is not adjusted to the attitude and motivation of the anesthesia assistant, this may also impact their credibility during the operation. It could even make them feel unappreciated for their efforts. This will also impact their relationship with the rest of the OR team. Hence, AI development that is adjusted based on the preferences of the user is also beneficial for those in the OR team that are directly or indirectly involved.

Additionally, developing an educational module that can support anesthesia assistants in their awareness and knowledge on AI-assisted monitoring and its impact on their motivation, may result in the occurrence of less events during the operation as the anesthesia assistants know how to respond and considerate the predictions and suggestions made by AI-assisted monitoring. This leads to less disturbances for the surgeon during the operation, as well as less calls for the anesthesiologist. Furthermore, the educational

module may contribute to the development towards a more deliberate professional as colleague for the OR team members.

Social relevance

The research on the development of AI for healthcare increases, meaning that when the development of AI will be implemented in practice the users will have to deal with this innovation. Investigation of the attitude of the users, anesthesia assistants, towards the development of AI-assisted monitoring that would impact their job, is therefore of major importance. A contribution to this investigation is done by this study, as well as on the investigation on their motivation. As AI-assisted monitoring could strongly impact the motivation of anesthesia assistants, research on their motivation as well as on their thoughts on the impact of AI on their motivation is very important. The development and implementation of AI-assisted monitoring must be adjusted to the users to ensure that AI-assisted monitoring will be useful and successful.

Thus, supporting anesthesia assistants at the OR by implementing AI in such way that it supports them in their task in a way they value, or in the form that AI can take over some tasks which allows them to have time for new tasks they value, increases the chances of satisfactory use of AI by the anesthesia assistant. This may positively contribute to the job satisfaction, and ultimately may even decrease the gap between supply and demand of personnel (Fernet, Chanal & Guay, 2017; Capaciteitsorgaan, 2018).

Furthermore, an indirect aim of the educational module is to involve anesthesia assistants in the emergence of AI in their profession, as AI would affect their work if it would be implemented. Enabling them to gain knowledge on AI, as well as on their motivation and the impact that AI might have on their motivation, allows them to create a funded opinion as well as to think along in the further development and use of AI. Enthusing them in learning more about their motivation and the impact of AI on their motivation, contributes to their development towards a deliberate professional. This is important as conscious decision-making and behaving is directly impacting the patient safety in the complex, continuously changing practice and working environment of anesthesia assistants. Furthermore, it might enable them to think more broadly, as was also experienced during the interviews, where anesthesia assistants were able to look beyond borders and see possibilities in potentially gaining new tasks and develop new competencies.

Additionally, the monitoring task of anesthesia assistants overlaps with tasks of medical support staff at the first aid department, intensive care unit and critical care unit, and to a lesser extent even more broadly in healthcare. The insights on the perception and attitude of anesthesia assistants towards the use of AI in their profession, and the preferences they have for the near future on AI implementation in their monitoring task, could therefore also be valuable for AI development in those departments.

Bibliography

Aggarwal, R., Mytton, O. T., Greaves, F., & Vincent, C. (2010). Technology as applied to patient safety: an overview. *Quality & Safety in Health Care*, *19 Suppl 2*(August).

Amann, J., Blasimme, A., Vayena, E., Frey, D., & Madai, V. I. (2020). Explainability for artificial intelligence in healthcare: a multidisciplinary perspective. *BMC Medical Informatics and Decision Making*, *20*(1), 1–9.

Anderson, T., & Shattuck, J. (2012). Design-based research: A decade of progress in education research?. *Educational researcher*, *41*(1), 16-25.

Apotheek.nl. (2020, October 28). *Efedrine.* Retrieved at March 17, 2022, from https://www.apotheek.nl/medicijnen/efedrine

Asan, O., Bayrak, A. E., & Choudhury, A. (2020). Artificial intelligence and human trust in healthcare: focus on clinicians. *Journal of medical Internet research*, *22*(6), e15154.

Babbie, E. (2016). The Practice of Social Research (14th edition). Cengage Learning.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review, 84*(2), 191–215.

Birkhoff, D. C., van Dalen, A. S. H. M., & Schijven, M. P. (2021). A Review on the Current Applications of Artificial Intelligence in the Operating Room. *Surgical Innovation*, *28*(5), 611–619.

Buetow, S. (2007). What motivates health professionals? Opportunities to gain greater insight from theory. *Journal of health services research & policy*, *12*(3), 183-185.

Buschmann, S., Chen, M. F., & Hauer, G. (2020). An integrated model of the theory of reasoned action and technology acceptance model to predict the consumers' intentions to adopt electric carsharing in Taiwan. In Innovations for Metropolitan Areas (pp. 105-120). Springer, Berlin, Heidelberg.

Capaciteitsorgaan. (2018). FZO-beroepen & Ambulanceverpleegkundigen. *Capaciteitsplan 2018-2021*, *november*. https://capaciteitsorgaan.nl/app/uploads/2018/11/20181024_FZO_DEF-Capaciteitsplan_2018_2021-vs3-EDIT.pdf

Carberry, A., Johnson, N., & Henderson, M. (2015). A practice-then-apply scaffolding approach to engineering design education. *Proceedings - Frontiers in Education Conference, FIE*, *2015-February*(February), 31–33.

Charness, N., & Boot, W. R. (2016). Technology, gaming, and social networking. In *Handbook of the Psychology of Aging* (pp. 389-407). Academic Press.

Cook, D. A., & Artino Jr, A. R. (2016). Motivation to learn: an overview of contemporary theories. *Medical education*, *50*(10), 997-1014.

Copeland, B.J. (2022, March 18) *Artificial Intelligence*. Brittanica. Retrieved at May 2, 2022 from https://www.britannica.com/technology/artificial-intelligence

Cross, N. (2004). Expertise in design: an overview. *Design Studies*, *25*, 427–441.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS quarterly*, 319-340.

De Wildt, S. N., Verzijden, R., van den Anker, J. N., & de Hoog, M. (2007). Information technology cannot guarantee patient safety. *BMJ*, *334*(7598), 851-852.

Deci, E. L., & Ryan, R. M. (1985). *Intrinsic motivation and self-determination in human behavior*. New York, NY: Plenum.

Deci, E.L., & Ryan, R.M. (2015). Self-Determination Theory. *International Encyclopedia of the Social & Behavioral Sciences (Second Edition),* 486-491.

Demo, D. H. (1985). The measurement of self-esteem: Refining our methods. *Journal of personality and social psychology*, *48*(6), 1490

Design Council (2022). *Double Diamond Model 2019*. Design Council. Retrieved at April 21, 2022, from https://www.designcouncil.org.uk/news-opinion/what-framework-innovation-design-councils-evolved-double-diamond

Dreessen, N. (LVO), & Hoorn, van M. (LVO). (2012). *Beroepsprofiel van de operatieassistent 2012*. 72. https://lvo.nl/sites/default/files/LVO_boek_06-binnenwerk 2kol_LO.pdf

Duda, J. L., & Appleton, P. R. (2016). Empowering and disempowering coaching climates: Conceptualization, measurement considerations, and intervention implications. *Sport and exercise psychology research*, 373-388

Dumont, G. A., & Ansermino, J. M. (2013). Closed-loop control of anesthesia: a primer for anesthesiologists. *Anesthesia & Analgesia*, *117*(5), 1130-1138.

Edwards Lifesciences Corporation. (2022). *HemoSphere advanced monitoring platform.* Edwards. Retrieved at May 3, 2022, from https://www.edwards.com/devices/hemodynamic-monitoring/hemosphere

EMY Commerce (May 30, 2020). *Operating room equipment* [Picture]. EMY. Retrieved at May 23, 2022, from https://emycommerce.com/index.php/2021/05/30/operating-room-equipment/

Fernet, C., Chanal, J., & Guay, F. (2017). What fuels the fire: job-or task-specific motivation (or both)? On the hierarchical and multidimensional nature of teacher motivation in relation to job burnout. *Work & Stress*, *31*(2), 145-163.

Fernet, C., Sencal, C., Guay, F., Marsh, H., & Dowson, M. (2008). The Work Tasks Motivation Scale for Teachers (WTMST). *Journal of Career Assessment*, *16*(2), 256–279.

Ferreira, A. L., Mendes, J. G., Nunes, C. S., & Amorim, P. (2019). Evaluation of Bispectral Index time delay in response to anesthesia induction: an observational study. *Brazilian Journal of Anesthesiology (English Edition)*, *69*(4), 377–382.

Fishbein, M., & Ajzen, I. (1977). Belief, attitude, intention, and behavior: An introduction to theory and research. *Philosophy and Rhetoric*, *10*(2).

Fumo, D. (2017, June 15). *Types of Machine Learning Algorithms You Should Know*. Towards Data Science. Retrieved at May 2, 2022, from https://towardsdatascience.com/types-of-machine-learning-algorithms-you-should-know-953a08248861

Gallagher, M. W. (2012). Self-Efficacy. In V.S. Ramachandran (Red.), *Encyclopedia of Human Behavior (Second Edition)* (pp. 314-320). Academic press.

Gauvain, M. (2020). Vygotsky's Sociocultural Theory. In J. B. Benson, *Encyclopedia of Infant and Early Childhood Development* (Second Edition, pp. 446-454). Elsevier.

Göras, C., Nilsson, U., Ekstedt, M., Unbeck, M., & Ehrenberg, A. (2020). Managing complexity in the operating room: a group interview study. *BMC health services research*, *20*(1), 1-12

Gu, Y., Liang, Z., & Hagihira, S. (2019). Use of multiple EEG features and artificial neural network to monitor the depth of anesthesia. *Sensors*, *19*(11), 2499.

Guest, G., Bunce, A., & Johnson, L. (2006). How many interviews are enough? An experiment with data saturation and variability. *Field methods*, *18*(1), 59-82.

Guillame-Bert, M., Dubrawski, A., Wang, D., Hravnak, M., Clermont, G., & Pinsky, M. R. (2017). Learning temporal rules to forecast instability in continuously monitored patients. *Journal of the American Medical Informatics Association: JAMIA*, *24*(1), 47–53.

Harrison, G. A. (1994). Principles of education and learning. *Baillière's clinical anaesthesiology*, *8*(3), 549-562.

Harzing, A. W., & Alakangas, S. (2016). Google Scholar, Scopus and the Web of Science: a longitudinal and cross-disciplinary comparison. *Scientometrics*, *106*(2), 787-804.

Hashimoto, D. A., Witkowski, E., Gao, L., Meireles, O., & Rosman, G. (2020). Artificial intelligence in anesthesiology: current techniques, clinical applications, and limitations. *Anesthesiology*, *132*(2), 379-394.

Hatib, F., Jian, Z., Buddi, S., Lee, C., Settels, J., Sibert, K., Rinehart, J., & Cannesson, M. (2018). Machine-learning Algorithm to Predict Hypotension Based on High-fidelity Arterial Pressure Waveform Analysis. *Anesthesiology*, *129*(4), 663–674.

Hengstler, M., Enkel, E., & Duelli, S. (2016). Applied artificial intelligence and trust—The case of autonomous vehicles and medical assistance devices. *Technological Forecasting and Social Change*, *105*, 105-120.

Hoffart, A. (2002). Guided Mastery Therapy. *Encyclopedia of Psychotherapy,* 907-910.

Holden, R. J., & Karsh, B. T. (2010). The technology acceptance model: its past and its future in health care. Journal of biomedical informatics, 43(1), 159-172.

Impact Law (2022). *Surgical Errors and Mistakes* [Picture]. ImpactLaw. Retrieved at May 23, 2022, from https://www.impactlaw.com/medical-malpractice/surgical-errors

Johnson, D. W., & Johnson, R. T. (2002). Learning together and alone: Overview and meta-analysis. *Asia Pacific Journal of Education*, *22*(1), 95-105.

Johnson, K. W., Torres Soto, J., Glicksberg, B. S., Shameer, K., Miotto, R., Ali, M., Ashley, E., & Dudley, J. T. (2018). Artificial Intelligence in Cardiology. *Journal of the American College of Cardiology*, *71*(23), 2668–2679.

Karels, M. (2020). Taxonomie van bloom. Retrieved at 14-4-22 from https://wij-leren.nl/taxonomie-van-bloom-uitleg.php

Karim, A. M., Nasouddin, S. S., Othman, M., Adzahan, M. N., & Hussin, S. R. (2011). Consumers' knowledge and perception towards Melicope ptelefolia (Daun Tenggek Burung): A preliminary qualitative study. *International Food Research Journal*, *18*(4), 1481.

Kelly, C. J., Karthikesalingam, A., Suleyman, M., Corrado, G., & King, D. (2019). Key challenges for delivering clinical impact with artificial intelligence. *BMC medicine*, *17*(1), 1-9.

Kendale, S., Kulkarni, P., Rosenberg, A. D., & Wang, J. (2018). Supervised machine-learning predictive analytics for prediction of postinduction hypotension. *Anesthesiology*, *129*(4), 675-688.

Khan, R. A., & Qudrat-Ullah, H. (2021). Technology Adoption Theories and Models. In *Adoption of LMS in Higher Educational Institutions of the Middle East* (pp. 27-48). Springer, Cham.

Koch, S. H., Proynova, R., Paech, B., & Wetter, T. (2014). The perfectly motivated nurse and the others: Workplace and personal characteristics impact preference of nursing tasks. *Journal of Nursing Management*, *22*(8), 1054–1064.

Koens, L. & Vennekens A. (2021, September 14). *Research on artificial intelligence in the Netherlands.* Rathenau. Retrieved on March 1, 2022, from https://www.rathenau.nl/en/science-figures/research-artificial-intelligence-netherlands

Laitinen, A., & Sahlgren, O. (2021). AI Systems and Respect for Human Autonomy. *Frontiers in artificial intelligence*, 151.).

Lawler, E. E., & Porter, L. W. (1967). The effect of performance on job satisfaction. *Industrial Relations, 7*(1), 20–28.

Lee, H. C., Ryu, H. G., Park, Y., Yoon, S. B., Yang, S. M., Oh, H. W., & Jung, C. W. (2019). Data driven investigation of bispectral index algorithm. *Scientific reports*, *9*(1), 1-8.

Silva, P. L., & Rocco, P. R. (2018). The basics of respiratory mechanics: ventilator-derived parameters. *Annals of translational medicine*, *6*(19).

Leiden Universitair Medisch Centrum. (n.d.) *OK-centrum*. LUMC. Retrieved at March 22, 2022, from https://www.lumc.nl/org/ok-centrum/

Leids Universitair Medisch Centrum. (2020). *LUMC Jaarverslag 2020 Grensverleggend > beter worden.* LUMC. Retrieved at 29-12-21 from https://www.lumc.nl/over-het-lumc/organisatie-en-missie/jaarverslag/

Leidse Onderwijs Instellingen. (n.d.) Taxonomie van Bloom (document). LOI

Lendl, M., Schwarz, U. H., Romeiser, H. J., Unbehauen, R., Georgieff, M., & Geldner, G. F. (1999). Nonlinear model-based predictive control of non-depolarizing muscle relaxants using neural networks. *Journal of clinical monitoring and computing*, *15*(5), 271-278.

Loftus, S., Gerzina, T., Higgs, J., Smith, M., & Duffy, E. (2013). *Educating health professionals: Becoming a university teacher*. BRILL.

Lowery, C., & Faisal, A. A. (2013). Towards efficient, personalized anesthesia using continuous reinforcement learning for propofol infusion control. In *2013 6th International IEEE/EMBS Conference on Neural Engineering (NER)* (pp. 1414-1417).

Lum, K. & Chowdhury, R. (2021, February 26). *What is an "algorithm"?.* MIT TechnologyReview. Retrieved at May 2, 2022, from https://www.technologyreview.com/2021/02/26/1020007/what-is-an-algorithm/

Lundberg, S. M., Nair, B., Vavilala, M. S., Horibe, M., Eisses, M. J., Adams, T., ... & Lee, S. I. (2018). Explainable machine-learning predictions for the prevention of hypoxaemia during surgery. *Nature biomedical engineering*, *2*(10), 749-760.

Lupke, M. (2019, October 16). *Exodus op de OK dreigt: 75% van het personeel overweegt te stoppen binnen 5 jaar.* OK Visie. Retrieved on February 10, 2022, from https://www.okvisie.nl/nieuws/exodus-op-de-ok-dreig-van-het-personeel-overweegt-te-stoppen-binnen-5-jaar

Maedche, A., Legner, C., Benlian, A., Berger, B., Gimpel, H., Hess, T., ... & Söllner, M. (2019). AI-based digital assistants. *Business & Information Systems Engineering*, *61*(4), 535-544.

Marques, B. P., Villate, J. E., & Carvalho, C. V. (2011). Applying the UTAUT model in engineering higher education: Teacher's technology adoption. In *6th Iberian Conference on Information Systems and Technologies (CISTI 2011)*, 1-6. IEEE.

Martinoni, E. P., Pfister, C. A., Stadler, K. S., Schumacher, P. M., Leibundgut, D., Bouillon, T., ... & Zbinden, A. M. (2004). Model-based control of mechanical ventilation: design and clinical validation. *British journal of anaesthesia*, *92*(6), 800-807.

Maslow, A. H. (1943). A theory of human motivation. *Psychological review*, *50*(4), 370.

Matheny, M., Israni, S. T., & Ahmed, M. (2018). Artifical Intelligence in Health Care. *National Academy of Medicine*, 1–269.

Matheny, M., Israni, S. T., Ahmed, M., & Whicher, D. (2019). Artificial intelligence in health care: the hope, the hype, the promise, the peril. *Washington, DC: National Academy of Medicine*.

Mathieson, K. (1991). Predicting user intentions: comparing the technology acceptance model with the theory of planned behavior. *Information systems research*, *2*(3), 173-191.

Mathis, M. R., Kheterpal, S., & Najarian, K. (2018). Artificial intelligence for anesthesia: what the practicing clinician needs to know: more than black magic for the art of the dark. *Anesthesiology*, *129*(4), 619-622.

Mathur, S., Patel, J., Goldstein, S., & Jain, A. (2021). Bispectral Index. In *StatPearls.* Treasure Island (FL): StatPearls Publishing.

McGrow, K. (2019). Artificial intelligence: Essentials for nursing. Nursing, 49(9), 46–49.

McLeod, S. (2007). Maslow's hierarchy of needs. *Simply psychology*, *1*(1-18).

Medical Advisory Secretariat (2004). Bispectral index monitor: an evidence-based analysis. *Ontario health technology assessment series*, *4*(9), 1–70.

Mirsadeghi, M., Behnam, H., Shalbaf, R., & Jelveh Moghadam, H. (2016). Characterizing awake and anesthetized states using a dimensionality reduction method. *Journal of Medical Systems*, *40*(1), 1-8.

Moore, B. L., Pyeatt, L. D., Kulkarni, V., Panousis, P., Padrez, K., & Doufas, A. G. (2014). Reinforcement learning for closed-loop propofol anesthesia: a study in human volunteers. *The journal of machine learning research*, *15*(1), 655-696.

Multon, K. D., Brown, S. D., & Lent, R. W. (1991). Relation of self-efficacy beliefs to academic outcomes: A meta-analytic investigation. *Journal of counseling psychology*, *38*(1), 30.

Murphy, D. G., Bjartell, A., Ficarra, V., Graefen, M., Haese, A., Montironi, R., ... & van der Poel, H. (2010). Downsides of robot-assisted laparoscopic radical prostatectomy: limitations and complications. *European urology*, *57*(5), 735-746.

Nederlandse Vereniging van Anesthesiemedewerkers. (2014). *Beroepsprofiel van de anesthesiemedewerker.* https://www.nvam.nl/documenten/11.1364/

Neri, E., Coppola, F., Miele, V., Bibbolino, C., & Grassi, R. (2020). Artificial intelligence: Who is responsible for the diagnosis?. *La radiologia medica*, *125*(6), 517-521.

Ngo, P.D., Nordsletta, A. T., Nasrabadi, M. T., Chomutare, T., Lind, K., Godtliebsen, F., Moen, A., Ruiz, L.M. (2021, March 23). *Report for AI Implementation in Healthcare.* Norwegian Centre for E-health Research. Retrieved on February 10, 2022, from https://ehealthresearch.no/en/projects/kunnskapsoppsummering-for-implementering-av-ki-i-helsetjenesten

Oken, B. S., Salinsky, M. C., & Elsas, S. (2006). Vigilance, alertness, or sustained attention: physiological basis and measurement. Clinical neurophysiology, 117(9), 1885-1901.

Olczak, J., Pavlopoulos, J., Prijs, J., Ijpma, F. F., Doornberg, J. N., Lundström, C., ... & Gordon, M. (2021). Presenting artificial intelligence, deep learning, and machine learning studies to clinicians and healthcare stakeholders: an introductory reference with a guideline and a Clinical AI Research (CAIR) checklist proposal. *Acta orthopaedica*, *92*(5), 513-525.

Orenstein, D. (February 14, 2022). Research advances technology of AI assistance for anesthesiologists. *MIT News*. Retrieved on May 5, 2022, from https://news.mit.edu/2022/research-advances-technology-ai-assistance-anesthesiologists-0214

Padmanabhan, R., Meskin, N., & Haddad, W. M. (2015). Closed-loop control of anesthesia and mean arterial pressure using reinforcement learning. *Biomedical Signal Processing and Control*, *22*, 54-64.

Park, S. J., Lee, E. J., Kim, S. I., Kong, S. H., Jeong, C. W., & Kim, H. S. (2020). Clinical Desire for an Artificial Intelligence–Based Surgical Assistant System: Electronic Survey–Based Study. *JMIR Medical Informatics*, *8*(5), e17647.

Ranta, S. O. V., Hynynen, M., & Räsänen, J. (2002). Application of artificial neural networks as an indicator of awareness with recall during general anaesthesia. *Journal of clinical monitoring and computing*, *17*(1), 53-60.

Rathenau Instituut. (2020). *Zeven acties voor verantwoord innoveren met AI*. https://www.rathenau.nl/sites/default/files/2021-02/Verantwoord_Innoveren_met_AI_Rathenau_Instituut.pdf

Reimann, P. (2011). Design-based research. In *Methodological choice and design* (pp. 37-50). Springer, Dordrecht.

Robert, N. (2019). How artificial intelligence is changing nursing. *Nursing management*, *50*(9), 30.

Rong, G., Mendez, A., Bou Assi, E., Zhao, B., & Sawan, M. (2020). Artificial Intelligence in Healthcare: Review and Prediction Case Studies. *Engineering*, *6*(3), 291–301.

Rush, B., Celi, L. A., & Stone, D. J. (2019). Applying machine learning to continuously monitored physiological data. *Journal of Clinical Monitoring and Computing*, *33*(5), 887–893.

Ryan, R. M., & Deci, E. L. (2000a). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American psychologist*, *55*(1), 68.

Ryan, R. M., & Deci, E. L. (2000b). The darker and brighter sides of human existence: Basic psychological needs as a unifying concept. *Psychological inquiry*, *11*(4), 319-338.

Ryan, R. M., & Deci, E. L. (2000c). Intrinsic and extrinsic motivations: Classic definitions and new directions. *Contemporary educational psychology*, *25*(1), 54-67.

Schamberg, G., Badgeley, M., Meschede-Krasa, B., Kwon, O., & Brown, E. N. (2022). Continuous action deep reinforcement learning for propofol dosing during general anesthesia. *Artificial Intelligence in Medicine*, *123*, 102227.

Schön, D. A. (1987). *Educating the reflective practitioner: Toward a new design for teaching and learning in the professions*. Jossey-Bass.

Schön, D. A. (2017). *The reflective practitioner: How professionals think in action*. Routledge.

Schönberger, D. (2019). Artificial intelligence in healthcare: a critical analysis of the legal and ethical implications. *International Journal of Law and Information Technology*, *27*(2), 171-203.

Schuller, P. J., Newell, S., Strickland, P. A., & Barry, J. J. (2015). Response of bispectral index to neuromuscular block in awake volunteers. *British journal of anaesthesia*, *115*(suppl_1), i95-i103.

Schunk, D. H. (1995). Self-efficacy, motivation, and performance. *Journal of applied sport psychology*, *7*(2), 112-137.

Schunk, D. H., & Pajares, F. (2009). Self-efficacy theory. *Handbook of motivation at school*, *35*, 54.

Scott, E. E., Wenderoth, M. P., & Doherty, J. H. (2020). Design-based research: a methodology to extend and enrich biology education research. *CBE—Life Sciences Education*, *19*(2), es11.

Shahrbabaki, P. M., Rafati, F., & Sarabi, R. E. (2020). Competence as an inevitable necessity for health care workers: a qualitative study. *Pakistan Journal of Medical and Health Sciences*, *14*(3), 1234-1239.

Stajkovic, A. D., & Luthans, F. (1998). Self-efficacy and work-related performance: A meta-analysis. *Psychological Bulletin, 124*(2), 240–261.

Shalbaf, A., Saffar, M., Sleigh, J. W., & Shalbaf, R. (2018). Monitoring the depth of anesthesia using a new adaptive neurofuzzy system. *IEEE journal of biomedical and health informatics*, *22*(3), 671-677.

Shameer, K., Johnson, K. W., Glicksberg, B. S., Dudley, J. T., & Sengupta, P. P. (2018). Machine learning in cardiovascular medicine: are we there yet?. *Heart*, *104*(14), 1156-1164.

Shaw, J., Rudzicz, F., Jamieson, T., & Goldfarb, A. (2019). Artificial Intelligence and the Implementation Challenge. *Journal of Medical Internet Research*, *21*(7).

Srinivasa, K. G., Sowmya, B. J., Shikhar, A., Utkarsha, R., & Singh, A. (2018). Data analytics assisted internet of things towards building intelligent healthcare monitoring systems: iot for healthcare. *Journal of Organizational and End User Computing (JOEUC), 30*(4), 83-103.

Stewart, J., Sprivulis, P., & Dwivedi, G. (2018). Artificial intelligence and machine learning in emergency medicine. *EMA - Emergency Medicine Australasia*, *30*(6), 870–874.

Stokols, D. S. (2008). Supplement issue on the science of team science. *American Journal of Preventive Medicine*, *35*(2S)

Stokols, D., Misra, S., Moser, R. P., Hall, K. L., & Taylor, B. K. (2008). The ecology of team science: understanding contextual influences on transdisciplinary collaboration. *American journal of preventive medicine*, *35*(2), S96-S115.

Strohm, L., Hehakaya, C., Ranschaert, E. R., Boon, W. P., & Moors, E. H. (2020). Implementation of artificial intelligence (AI) applications in radiology: hindering and facilitating factors. *European radiology*, *30*(10), 5525-5532.

Studer, B., & Knecht, S. (2016). A benefit–cost framework of motivation for a specific activity. *Progress in brain research*, *229*, 25-47

Svensson, M. S., Heath, C., & Luff, P. (2007). Instrumental action: The timely exchange of implements during surgical operations. In *ECSCW 2007* (pp. 41–60). Springer, London.

Taherdoost, H. (2018). A review of technology acceptance and adoption models and theories. *Procedia Manufacturing*, *22*, 960–967.

Tang, K. J., Ang, C. K., Constantinides, T., Rajinikanth, V., Acharya, U. R., & Cheong, K. H. (2021). Artificial intelligence and machine learning in emergency medicine. *Biocybernetics and Biomedical Engineering, 41*(1), 156-172.

Tekkeşin, A. İ. (2019). Artificial Intelligence in Healthcare: Past, Present and Future. *Anatolian Journal of Cardiology*, *22*, 8–9.

Thomson, P., & Jaque, S. V. (2016). *Creativity and the performing artist: Behind the mask*. Academic Press.

Trede, F., & Jackson, D. (2021). Educating the deliberate professional and enhancing professional agency through peer reflection of work-integrated learning. *Active Learning in Higher Education*, *22*(3), 171-187.

Trede, F., McEwen, C. (2016). Scoping the Deliberate Professional. In: Trede, F., McEwen, C. (eds) Educating the Deliberate Professional. Professional and Practice-based Learning, vol 17. Springer, Cham

Trede, F., McEwen, C., & Ryan, C. (2021). Educating the deliberate professional: Preparing for future practices. *Australian Journal of Adult Learning*, *61*(2), 298-303.

University of Florida (n.d.). *Bloom's taxonomy graphic description*. Center for Instructional Technology and Training. Retrieved at April 14, 2022 from https://citt.ufl.edu/resources/the-learning-process/designing-the-learning-experience/blooms-taxonomy/blooms-taxonomy-graphic-description/

Van der Sanden, M. C., & Vries, M. J. D. (2016). Innovation in science and technology education and communication through design thinking. In *Science and Technology Education and Communication* (pp. 129-145). SensePublishers, Rotterdam.

Van Schoten, S. M., Kop, V., De Blok, C., Spreeuwenberg, P., Groenewegen, P. P., & Wagner, C. (2014). Compliance with a time-out procedure intended to prevent wrong surgery in hospitals: results of a national patient safety programme in the Netherlands. *BMJ open*, *4*(7), e005075.

Vroom, V. H. (1964). Work and motivation. San Francisco: Jossey-Bass.

Vuyk, J., Egberink, E. J., & Burm, A. G. (2004). Bispectraalanalyse van het elektro-encefalogram: een nieuwe methode van bewustzijnsregistratie tijdens anesthesie. *Nederlands tijdschrift voor geneeskunde, 148*(26), 1276-1280

Vygotsky, L. S., & Cole, M. (1978). *Mind in society: Development of higher psychological processes*. Harvard university press.

Wang, W., Chen, L., Xiong, M., & Wang, Y. (2021). Accelerating AI Adoption with Responsible AI Signals and Employee Engagement Mechanisms in Health Care. Information Systems Frontiers, 1-18.

Weller, J., & Boyd, M. (2014). Making a difference through improving teamwork in the operating room: a systematic review of the evidence on what works. *Current Anesthesiology Reports*, *4*(2), 77-83.

Wilson, L. O. (2016). Anderson and Krathwohl Bloom's Taxonomy Revised Understanding the New Version of Bloom's Taxonomy. *The Second Principle*, 1–8.

Wilson, K., & Devereux, L. (2014). Scaffolding theory: High challenge, high support in Academic Language and Learnin (ALL) contexts. *Journal of Academic Language & Learning*, *8*(3), 91–100.

World Medical Association. (2013). Declaration of Helsinki: Ethical Principles for Medical Research Involving Human Subjects. *JAMA, 310*(20), 2191–2194.

Yu, K. H., Beam, A. L., & Kohane, I. S. (2018). Artificial intelligence in healthcare. *Nature Biomedical Engineering*, *2*(10), 719–731.

Zaouter, C., Hemmerling, T. M., Lanchon, R., Valoti, E., Remy, A., Leuillet, S., & Ouattara, A. (2016). The feasibility of a completely automated total IV anesthesia drug delivery system for cardiac surgery. *Anesthesia & Analgesia*, *123*(4), 885-893.

Appendices – Table of contents

Appendix A) Operationalisation table

Table A.1. Operationalisation of the perception of AI at the OR, behavioural intention to use AI-assisted monitoring, task-related motivation in patient monitoring, and impact of AI-assisted monitoring on motivation. Theoretical substantiations and explanations of the definitions of the constructs and variables can be found in Chapter 2.

Construct	*Construct definition*	**Related variables**	*Variable definition*	**Indicators**	**Interview questions**
Perception of AI at the OR	*The perception, or image, about the possibilities of AI at the OR*			- Knowledge of the possibilities of AI at the OR - Interest in the use of AI at the OR - Expectations of AI at the OR	- Horen jullie wel eens wat over AI-ontwikkelingen? Word er over AI mogelijkheden gesproken tussen anesthesiemedewerkers onderling / binnen het OK-team? - Welk beeld heb je bij AI in het algemeen? En bij AI op de OK? - Wat verwacht je van AI?
Behavioural intention to use AI-assisted monitoring	*The willingness to endeavour to perform the behaviour of using AI-assisted monitoring in the task of patient monitoring*	**Attitude towards the behaviour of using AI-assisted monitoring**	*Overall assessment and beliefs about the behaviour of using AI-assisted monitoring*	- General attitude towards introduction of AI at the OR in the form of AI-assisted monitoring by prediction of risk factors - Preferences or desires of the role that AI-assisted monitoring could play at the OR, - Concerns on the impact or effects of the use of AI-assisted monitoring	- Hoe sta jij in het algemeen tegenover de introductie van AI op de OK? - Als die apparaten wellicht in de toekomst geheel autonoom zouden kunnen werken, dat ze o.b.v. bepaalde metingen zelf de medicatie zouden kunnen aanpassen zonder enige tussenkomst van AM? Hoe kijk je daar tegenaan? - Zou je er wat voor voelen dat AI kan voorspellen of een patiënt extra medicatie nodig heeft? - Zou je er wat voor voelen dat AI kan voorspellen dat er een event gaat optreden over een bepaalde tijd? - Welke apparaten (of taken in het monitoren) zou jij verbetering in willen zien; zou AI hier een bijdrage kunnen leveren? Hoe zie je dit dan voor je? - Ben je bang dat je minder oplettend zal gaan worden? En minder zelf gaat nadenken? Of kan het juist ervoor zorgen dat je meer gaat beredeneren o.b.v. wat AI voorspelt? - Zie je het als een samenwerking met AI? - Hoe ervaar je werkdruk en personeelstekort in jouw baan? Zou AI de werkdruk kunnen verlagen?
		Perceived usefulness	*Perception whether using AI will enhance the monitoring performance*	- Expectations of AI in increasing or decreasing the effectivity of the monitoring	- Denk je dat het zal bijdragen aan de effectiviteit van het monitoren?
		Perceived ease of use	*Perception that using AI will take or take no effort and therefore whether the monitoring task will take more or less effort*	- Expectations of AI in increasing or decreasing the amount of effort the monitoring will take	- Heb je verwachtingen dat het gebruik van AI moeite zal kosten? - Heb je verwachtingen dat het monitoren meer/minder moeite zal gaan kosten?

		Subjective norm	*Social pressure by colleagues and people of importance/management to use or do not use AI*	- Whether their acceptance depends on the opinions and acceptance of supervisors and colleagues, and the opinions and acceptance of friends	- Hangt jouw acceptatie van AI ook af van je leidinggevenden / collega's? Zou je het sneller accepteren als zij het accepteren? (En vrienden?)
Task-related motivation in patient monitoring	*Motivation to initiate the task of patient monitoring and the perception that the task is worth pursuing*	**Self-identified motivational factors**	*Self-identified features important for their motivation in patient monitoring*	- Self-identified features in the monitoring task that are found important for motivation to perform the task	- Wat zijn dingen in jouw monitoringstaken die jij belangrijk vindt voor je motivatie om die taken te doen? - Zijn er na deze voorbeelden nog andere aspecten die niet genoemd zijn die jij belangrijk vindt voor je motivatie?
		Autonomy	*The ability to have input, make decisions, and have responsibilities*	- How important autonomy is for the motivation in monitoring on a Likert scale of unimportant to very important - How important autonomy is for the motivation in monitoring, compared to the other factors of relatedness, competence, self-efficacy and self-actualisation - How autonomy is related to the other factors of relatedness, competence, self-efficacy, and self-actualisation	- Hoe belangrijk is het voor jouw motivatie dat je autonomie hebt in het monitoren? Hieronder valt: eigen keuzes kunnen en mogen maken & verantwoordelijkheden. Op een scale van: onbelangrijk / enigszins belangrijk / redelijk belangrijk / belangrijk / zeer belangrijk. En waarom? - Welke van de factoren van autonomie (eigen keuzes, verantwoordelijkheden), verwantschap (verbondenheid met collega's, taken), competenties, zelfactualisatie en zelf-effectiviteit, … (andere genoemde factoren) zijn het meest van belang en welke het minste voor jouw motivatie? Dus welke zou je op plaats 5 t/m 1 zetten, met 5 minst van belang en 1 meest van belang. - En zijn er bepaalde factoren die invloed hebben op elkaar? Of zijn er andere aspecten van invloed op deze factoren? (->alle mogelijke verbanden nagaan, wat is de aard van de relatie en waarom?).
		Relatedness	*Feeling connected with colleagues, and the multidisciplinary operating team at duty, and feeling connected with the monitoring task*	- How important relatedness with colleagues and the team, and relatedness with the task, is for the motivation in monitoring on a Likert scale of unimportant to very important - How important relatedness is for the motivation in monitoring, compared to the other factors of autonomy, competence, self-efficacy and self-actualisation - How relatedness is related to the other factors of autonomy, competence, self-efficacy, and self-actualisation	- Hoe belangrijk is het voor jouw motivatie dat je je verbonden voelt met je team/collega's tijdens het monitoren? En je verbonden voelt met de taken die je doet tijdens het monitoren? Op een scale van: onbelangrijk / enigszins belangrijk / redelijk belangrijk / belangrijk / zeer belangrijk. En waarom? - Welke van de factoren van autonomie (eigen keuzes, verantwoordelijkheden), verwantschap (verbondenheid met collega's, taken), competenties, zelfactualisatie en zelf-effectiviteit, … (andere genoemde factoren) zijn het meest van belang en welke het minste voor jouw motivatie? Dus welke zou je op plaats 5 t/m 1 zetten, met 5 minst van belang en 1 meest van belang. - En zijn er bepaalde factoren die invloed hebben op elkaar? Of zijn er andere aspecten van invloed op deze factoren? (->alle mogelijke verbanden nagaan, wat is de aard van de relatie en waarom?).

		Competence	*Feeling competent, meaning that one feels that they have the competencies to be able to meet the demands and responsibilities of their monitoring task*	- How important feeling competent is for the motivation in monitoring on a Likert scale of unimportant to very important - How important competence is for the motivation in monitoring, compared to the other factors of autonomy, relatedness, self-efficacy and self-actualisation - How competence is related to the other factors of autonomy, relatedness, self-efficacy, and self-actualisation	- Hoe belangrijk is het voor jouw motivatie dat je het gevoel hebt dat je bepaalde competenties hebt (je competent voelen) die benodigd zijn voor je monitoringstaken en verantwoordelijkheden daarin? Op een scale van: onbelangrijk / enigszins belangrijk / redelijk belangrijk / belangrijk / zeer belangrijk. En waarom? - Welke van de factoren van autonomie (eigen keuzes, verantwoordelijkheden), verwantschap (verbondenheid met collega's, taken), competenties, zelfactualisatie en zelf-effectiviteit, … (andere genoemde factoren) zijn het meest van belang en welke het minste voor jouw motivatie? Dus welke zou je op plaats 5 t/m 1 zetten, met 5 minst van belang en 1 meest van belang. - En zijn er bepaalde factoren die invloed hebben op elkaar? Of zijn er andere aspecten van invloed op deze factoren? (->alle mogelijke verbanden nagaan, wat is de aard van de relatie en waarom?).
		Self-efficacy	*Perception, or own judgement and confidence, that their own capabilities are on such level that one is able to perform the monitoring task successfully*	- How important self-efficacy is for the motivation in monitoring on a Likert scale of unimportant to very important - How important self-efficacy is for the motivation in monitoring, compared to the other factors of autonomy, relatedness, competence, and self-actualisation - How self-efficacy is related to the other factors of autonomy, relatedness, competence, and self-actualisation - Whether verbal persuasion, being encouraged by colleagues and getting their positive feedback, increases one his self-efficacy - Whether performance accomplishment, performing actions successfully while solving potential issues, increases one his self-efficacy	- Hoe belangrijk is het voor jouw motivatie dat je gelooft in je eigen kunnen om in je monitoringstaken het juiste te doen, de uitdagingen aan te kunnen? Op een scale van: onbelangrijk / enigszins belangrijk / redelijk belangrijk / belangrijk / zeer belangrijk. En waarom? - In hoeverre hebben de volgende punten invloed op je geloof in je eigen kunnen? Aangemoedigd worden door collega's/complimenten krijgen? Bepaalde handelingen met succes uitvoeren? Andere mensen de taak zien uitvoeren? Fysiologische opwinding: dat je de spanning voelt, je bloeddruk en hartslag omhoog gaat etc.? En hoeveel zijn die laatste 4 punten van invloed op je motivatie? - Welke van de factoren van autonomie (eigen keuzes, verantwoordelijkheden), verwantschap (verbondenheid met collega's, taken), competenties, zelfactualisatie en zelf-effectiviteit, … (andere genoemde factoren) zijn het meest van belang en welke het minste voor jouw motivatie? Dus welke zou je op plaats 5 t/m 1 zetten, met 5 minst van belang en 1 meest van belang. - En zijn er bepaalde factoren die invloed hebben op elkaar? Of zijn er andere aspecten van invloed op deze factoren? (->alle mogelijke verbanden nagaan, wat is de aard van de relatie en waarom?).

				- Whether vicarious experiences, observing other people cope with the task, increases one his self-efficacy - Whether physiological arousal, being in a state of high alertness so feeling tension, the increase of blood pressure and heart rate, increases one his self-efficacy	
		Self-actualisation	*Developing and fulfilling of one their talents and potential, amongst others by learning new things and learning from others*	- How important self-actualisation is for the motivation in monitoring on a Likert scale of unimportant to very important - How important self-actualisation is for the motivation in monitoring, compared to the other factors of autonomy, relatedness, competence, and self-efficacy - How self-actualisation is related to the other factors of autonomy, relatedness, competence, and self-efficacy	- Hoe belangrijk is het voor jouw motivatie dat je nieuwe dingen kunt leren, dingen kunt leren van anderen en jezelf/jouw kwaliteiten, talenten en vaardigheden (verder) kunt ontwikkelen? Op een scale van: onbelangrijk / enigszins belangrijk / redelijk belangrijk / belangrijk / zeer belangrijk. En waarom? - Welke van de factoren van autonomie (eigen keuzes, verantwoordelijkheden), verwantschap (verbondenheid met collega's, taken), competenties, zelfactualisatie en zelf-effectiviteit, … (andere genoemde factoren) zijn het meest van belang en welke het minste voor jouw motivatie? Dus welke zou je op plaats 5 t/m 1 zetten, met 5 minst van belang en 1 meest van belang. - En zijn er bepaalde factoren die invloed hebben op elkaar? Of zijn er andere aspecten van invloed op deze factoren? (->alle mogelijke verbanden nagaan, wat is de aard van de relatie en waarom?).
Impact of AI-assisted monitoring on motivation	*Negative or positive influence of the use of AI-assisted monitoring on the motivational factors of autonomy, relatedness, competence, self-efficacy, and self-actualisation.*			- What motivational factors are positively/negatively influenced by the use of AI-assisted monitoring if AI would make predictions and give suggestions - What motivational factors are positively/negatively influenced by the use of AI-assisted monitoring if AI autonomously would give medications based on its measurements and predictions	- Op welke factoren denk je dat AI positief of negatief van invloed kan zijn (voor jou)? Hoe (positief/negatief), en waarom? Hoe is dat als AI suggesties geeft / risicofactoren voorspelt en waarschuwt? Hoe is dat als AI autonoom extra medicatie bij zou geven o.b.v. de metingen?

Appendix B) Interview Protocols

This Appendix contains multiple interview protocols, as the interview protocol was adjusted based on input of previous interviews. The questions about the OR and the tasks and responsibilities, and complexity within those tasks, have varied from multiple general questions in the first interview protocol (interview protocol AM1), to only a few questions in the following interview protocols, and some more detailed questions in the final interview protocol (interview protocol AM7). A question on the possibility of devices to give medication autonomously is only included in the first interview protocol. In the last interview protocol, also extra questions are added regarding regulations, time pressure, and the role of evidence-based practice. Furthermore, in the last interview protocol, some specific questions regarding alarm fatigue, alertness, self-thinking, workload, and personnel shortage are added. The questions regarding the interactions within the OR team are only included in interview protocol AM1 and, to a lesser extent, in interview protocol AM2.

Starting from the second interview protocol (interview protocol AM2), two questions on the perceived ease of use and perceived usefulness of AI-assisted monitoring are included. Furthermore, in interview protocol AM6 and interview protocol AM7, specific questions regarding the impact of AI on the motivational factors are added.

Finally, from the second interview protocol on, questions about the setup of an educational module are included. For interview protocol AM2, interview protocol AM3, AM4, AM5, and interview protocol AM6, this included questions on whether such an educational module would be of interest, what it should include, and when in their educational development the module should be introduced. For interview protocol AM7, more detailed questions were included about how deeply one would want to learn about the working principle and about the explainability of AI, as well as a specific question regarding the interest to learn about motivation. Additionally, in this last interview protocol a question was included about what the continuing education of anesthesia assistants comprises.

This Appendix first contains the general introduction that was used for each interview, after which the different interview protocols can be found.

In het algemeen:

- Welkom heten
- Toestemming vragen voor geluidsopname van interview
- Vragen van geïnterviewde beantwoorden betreffende het onderzoek, met nadruk dat het gaat om anoniem gegevens gebruik.
- Informed consent formulier laten tekenen
- Tijdsaanduiding geven en vragen hoeveel tijd de geïnterviewde maximaal heeft
- Introductie op onderzoek, die van tevoren gestuurd is, kort samenvattend herhalen:

Introductie van de *reden* van het interview:

De reden dat ik dit interview met je wil doen is vanwege mijn **onderzoek** naar de **introductie** van artificiële intelligentie (**AI**) op de **OK**. Het gebruik van AI is namelijk opkomend, maar is in de gezondheidszorg, in tegenstelling tot in andere disciplines (bijv. de Google Assistant of Siri), nog volledig in de **ontwikkelingsfase**. Aangezien ik begrepen heb dat **werken in de OK als anesthesiemedewerker best zwaar is** door een toename in het aantal hoog complexe operaties, personeelstekorten, veel protocollen, en steeds meer technologie, wil ik **kijken of en hoe AI een rol zou kunnen spelen in het ondersteunen bij taken: monitoren** van anesthesiemedewerkers.

Doel van het interview: Het in kaart brengen van de wensen van anesthesiemedewerkers met betrekking tot de introductie van AI. Ik vind het belangrijk dat áls AI in de toekomst geïntroduceerd zou worden dit **aansluit bij de wensen van anesthesiemedewerkers**, **zodat zij er het meeste aan hebb**en. Daarom wil ik er met interviews achter komen wat de **houding** van anesthesiemedewerkers **is t.o.v. AI** en waar zij de **meeste kansen** zien of het **liefste ondersteuning** of overname zouden willen.

Ook is het belangrijk dat de **motivatie van anesthesiemedewerkers** in stand blijft tijdens het monitoren, en dat **AI dit niet wegneemt** maar misschien juist kan verbeteren. Daarom wil ik in kaart brengen welke **motivatiefactoren** van invloed zijn in jullie baan tijdens het **monitoren** van patiënten.

- semi-structured interviewvragen
- Bedanken
- Benadrukken zorgvuldige omgang met data

Interview Protocol AM1

Introductie OK & taken/verantwoordelijkheden
- Kun jij **kort** vertellen wat een **OK inhoudt** en **wie er werken**?
- Wat zijn jouw **taken als AM**? Algemeen: kort & in detail: **monitoren**.
En wat zijn precies je **verantwoordelijkheden**?
(zijn er bij het monitoren ook nog registratie/documentatie taken?)

- Met welke **apparaten** heb je allemaal te maken **tijdens het monitoren**?
(beademingsapparatuur, medicatie, …)
- Welke **taken vallen samen (tegelijkertijd)** met de monitoringstaken?

- Met wie heb je allemaal **interactie tijdens de monitoringstaak**? In welke **richting(en)** zijn die interacties?
- Is daarin sprake van **hiërarchie**?
- Hoe hebben de **anderen invloed** op de **keuzes** die jij maakt?

- Bij welke omstandigheden wordt een **anesthesist opgeroepen** om erbij te komen?
Zou je wellicht willen dat dit automatisch gaat? Of juist niet, dat je dit zelf kunt beslissen?

- Zijn er andere factoren/aspecten die ook jouw monitoringstaken **complexer** maken (dus complexer dan puur de taak op zich uitvoeren)?
(- Zijn er bijv. protocollen die je moet volgen?)

Samen leren
- Als er **nieuwe technologieën of ontwikkelingen** zijn, vindt er dan 'samen leren' binnen het OK-team plaats? Worden die dan met het gehele team besproken? Of vindt dit alleen per discipline plaats?
- En bij **complexe operaties**, worden die van tevoren met het hele team doorgesproken? Hoe weet iedereen precies wat hij/zij moet doen?
- En **feedback en evaluaties**, is hier ook sprake van 'samen leren' als OK-team? Worden die in het gehele team besproken? Krijg je überhaupt feedback van collega's/mensen uit de rest van het OK-team? Krijg je kansen om van elkaar te leren?
- Horen jullie wel eens wat over AI-ontwikkelingen? Word er **over AI mogelijkheden** gesproken tussen anesthesiemedewerkers onderling / binnen het OK-team?

AI acceptatie
- Welk **beeld** heb je bij AI in het algemeen? En bij AI op de OK?

- Hoe sta jij in het **algemeen tegenover de introductie van AI** op de OK?

- Wat **verwacht je van AI?**

- Zou je er wat voor voelen dat **AI kan voorspellen of een patiënt extra medicatie** nodig heeft: sedatie / pijnmedicatie / inotropica / …

- Hangt jouw acceptatie van AI ook af van je leidinggevenden / collega's? Zou je het sneller accepteren als zij het accepteren?

Apparatuur (/AI mogelijkheden)
- Zijn er **apparaten** die (door op wat knoppen te drukken) **extra medicatie geven / teugvolume bijstellen** etc.? Welke apparaten kun je hier allemaal bij bedenken?
- Denk je dat die **apparaten** dat wellicht in de toekomst geheel **autonoom** zouden kunnen? Dat ze o.b.v. bepaalde metingen zelf dit aanpassen zonder enige tussenkomst van AM? Hoe kijk je daar tegenaan?
- Welke **apparaten** (of taken) **zou jij verbetering in willen zien**; zou AI hier een bijdrage kunnen leveren? Hoe zie je dit dan voor je?
(Eventueel VB: BIS-monitor)
(- Gaan er veel alarmen af van apparaten? Ervaar je dat als te weinig/te veel/goed? Zou je hierin iets willen

aanpassen? Bijv. **geïntegreerde alarmen** (data samenvoegen en vergelijken met eerdere operaties) die daardoor ook minder vaak afgaan?)

Motivatie

(open)- Wat zijn dingen in jouw monitoringstaken die jij **belangrijk vindt voor je motivatie** om die taken te doen?

(a.d.h.v. factoren sturen): Op basis van mijn literatuuronderzoek zijn er bepaalde factoren naar voren gekomen die gerelateerd zijn aan motivatie. Graag wil ik jou vragen in hoeverre deze motivatie factoren ook van invloed zijn op jouw motivatie.

- hoe belangrijk is het voor jouw motivatie dat je

(op schaal: onbelangrijk / enigszins belangrijk / redelijk belangrijk / belangrijk / zeer belangrijk)

Autonomie:

- **autonomie** hebt in het monitoren? Hieronder valt: **eigen keuzes kunnen en mogen maken & verantwoordelijkheden.**

Verbondenheid:

- je verbonden voelt met je team/collega's tijdens het monitoren?

- **je verbonden voelt met de taken die je doet** tijdens het monitoren?

Competentie

- het **gevoel hebt dat je bepaalde competenties hebt (je competent voelen)** die benodigd zijn voor je monitoringstaken en verantwoordelijkheden daarin?

Zelfactualisatie

- nieuwe dingen kunt **leren?** En dingen kunt **leren van anderen?**

- jezelf/jouw kwaliteiten, talenten en vaardigheden (verder) kunt **ontwikkelen?**

Zelf-effectiviteit:

- gelooft in je eigen kunnen om in je monitoringstaken het juiste te doen, de uitdagingen aan te kunnen?

In hoeverre hebben de volgende punten invloed op je geloof in je eigen kunnen?

- aangemoedigd worden door collega's/complimenten krijgen**?**

- bepaalde **handelingen met succes uitvoeren?**

- andere mensen de taak zien uitvoeren?

- fysiologische opwinding: dat je de spanning voelt, je bloeddruk en hartslag omhoog gaat etc.?

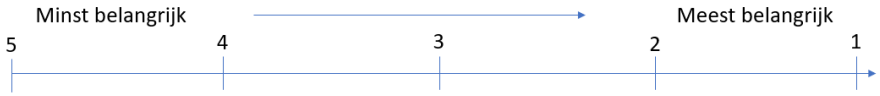
Hoeveel zijn die laatste 4 punten van invloed op je motivatie?

(open)- Zijn er na deze voorbeelden nog **andere aspecten die niet genoemd zijn die jij belangrijk vindt voor je motivatie**?

- Welke van de factoren van autonomie (eigen keuzes, verantwoordelijkheden), verwantschap (verbondenheid met collega's, taken), competenties, zelfactualisatie en zelf-effectiviteit, … (andere genoemde factoren) zijn het **meest van belang en welke het minste voor jouw motivatie**?

Dus welke zou je op **plaats 5 t/m 1** zetten, met 5 minst van belang en 1 meest van belang.

-> Kaartjes



Autonomie
- zelf keuzes kunnen maken
- verantwoordelijkheden

Verbondenheid
- met team / collega's
- monitoringstaken

Competentie
- competent voelen
voor monitoringstaken
& verantwoordelijkheden
daarin

Zelfactualisatie
- nieuwe dingen leren
(zelf / van anderen)
-jezelf/jouw kwaliteiten en talent
kunnen ontwikkelen

Zelf-effectiviteit
- geloof in je eigen kunnen: het
juiste doen, uitdagingen
aankunnen

- En zijn er bepaalde factoren die **invloed hebben op elkaar**? Of zijn er andere **aspecten van invloed op deze factoren**?
(->alle mogelijke verbanden nagaan, wat is de aard van de relatie en waarom?).

-> Kaartjes

Verbondenheid
- met team / collega's
- monitoringstaken

Autonomie
- zelf keuzes kunnen maken
- verantwoordelijkheden

Competentie
- competent voelen
voor monitoringstaken
& verantwoordelijkheden
daarin

Zelfactualisatie
- nieuwe dingen leren
(zelf / van anderen)
-jezelf/jouw kwaliteiten en
talent kunnen ontwikkelen

Zelf-effectiviteit
- geloof in je eigen kunnen:
het juiste doen,
uitdagingen aankunnen

Interview Protocol AM2

Introductie OK & taken/verantwoordelijkheden
- Heel kort: Wat zijn jouw **taken als AM** in het **monitoren**?

- Met welke **apparaten** heb je allemaal te maken **tijdens het monitoren**?
(beademingsapparatuur, medicatie, …)

- Zijn er andere factoren/aspecten die ook jouw monitoringstaken **complexer** maken (dus complexer dan puur de taak op zich uitvoeren)?
(- Zijn er bijv. protocollen die je moet volgen? Documentatiehandelingen (medicatie?))

Samen leren
"Je werkt in een OK team, vooral samen met de anesthesioloog, maar ook de chirurg en operatieassistenten etc."
- is hier sprake van 'samen leren' als OK-team in de vorm van **feedback en evaluaties**? Worden die in het gehele team besproken? Krijg je überhaupt feedback van collega's/mensen uit de rest van het OK-team? Krijg je kansen om van elkaar te leren?
- Horen jullie wel eens wat over AI-ontwikkelingen? Word er **over AI mogelijkheden** gesproken tussen anesthesiemedewerkers onderling / binnen het OK-team?

AI acceptatie
- Welk **beeld** heb je bij AI in het algemeen? En bij AI op de OK?

Als onduidelijk is wat AI kan: kan je zien als een computer die heel veel data heeft, en de data die hij meet: vitale parameters kan hij vergelijken met eerdere data en ook patiëntgegevens (als gewicht, eerdere aandoeningen) daarin meenemen. Bijvoorbeeld als er meerdere operaties geweest zijn waarbij een plotselinge lage vitale waarde met een hoge andere vitale waarde tot iets leidde, dan kan AI waarschuwen dat bepaalde medicatie nodig is of dat je alert moet zijn op iets specifieks.

- Hoe sta jij in het **algemeen tegenover de introductie van AI** op de OK?

- Wat **verwacht je van AI?**
    - **Denk je dat het zal bijdragen aan de effectiviteit van het monitoren?**
    - **Heb je verwachtingen dat het monitoren meer/minder moeite zal gaan kosten?**

- Hangt jouw acceptatie van AI ook af van je leidinggevenden / collega's? Zou je het sneller accepteren als zij het accepteren?

- Zou je er wat voor voelen dat **AI kan voorspellen of een patiënt extra medicatie** nodig heeft: sedatie / pijnmedicatie / inotropica / …

- Als die **apparaten** wellicht in de toekomst geheel **autonoom** zouden kunnen werken, dat ze o.b.v. bepaalde metingen zelf de medicatie zouden kunnen aanpassen zonder enige tussenkomst van AM? Hoe kijk je daar tegenaan?
- Welke **apparaten** (of taken in het monitoren) **zou jij verbetering in willen zien**; zou AI hier een bijdrage kunnen leveren? Hoe zie je dit dan voor je?
(Eventueel VB: BIS-monitor, registratie medicatie, alarmen, …)

Motivatie
(open)- Wat zijn dingen in jouw monitoringstaken die jij **belangrijk vindt voor je motivatie** om die taken te doen?
(a.d.h.v. factoren sturen): Op basis van mijn literatuuronderzoek zijn er bepaalde factoren naar voren gekomen die gerelateerd zijn aan motivatie. Graag wil ik jou vragen in hoeverre deze motivatie factoren ook van invloed zijn op jouw motivatie.

- hoe belangrijk is het voor jouw motivatie dat je
(op schaal: onbelangrijk / enigszins belangrijk / redelijk belangrijk / belangrijk / zeer belangrijk)

Autonomie:
- **autonomie** hebt in het monitoren? Hieronder valt: **eigen keuzes kunnen en mogen maken & verantwoordelijkheden.**

Verbondenheid:
- **je verbonden voelt met je team/collega's** tijdens het monitoren?
- **je verbonden voelt met de taken die je doet** tijdens het monitoren?

Competentie
- het **gevoel hebt dat je bepaalde competenties hebt (je competent voelen)** die benodigd zijn voor je monitoringstaken en verantwoordelijkheden daarin?

Zelfactualisatie
- nieuwe dingen kunt **leren?** En dingen kunt **leren van anderen?**
- **jezelf/jouw kwaliteiten, talenten en vaardigheden** (verder) kunt **ontwikkelen?**

Zelf-effectiviteit:
- **gelooft in je eigen kunnen** om in je monitoringstaken het juiste te doen, de uitdagingen aan te kunnen?

In hoeverre hebben de volgende punten invloed op jouw geloof in je eigen kunnen?
→ Ja/beetje/niet echt.
- **aangemoedigd worden** door collega's/complimenten krijgen**?**
- bepaalde **handelingen met succes uitvoeren?**
- **andere mensen de taak zien uitvoeren?**
- **fysiologische opwinding:** dat je de spanning voelt, je bloeddruk en hartslag omhoog gaat etc.?

(open)- Zijn er na deze voorbeelden nog **andere aspecten die niet genoemd zijn die jij belangrijk vindt voor je motivatie**?

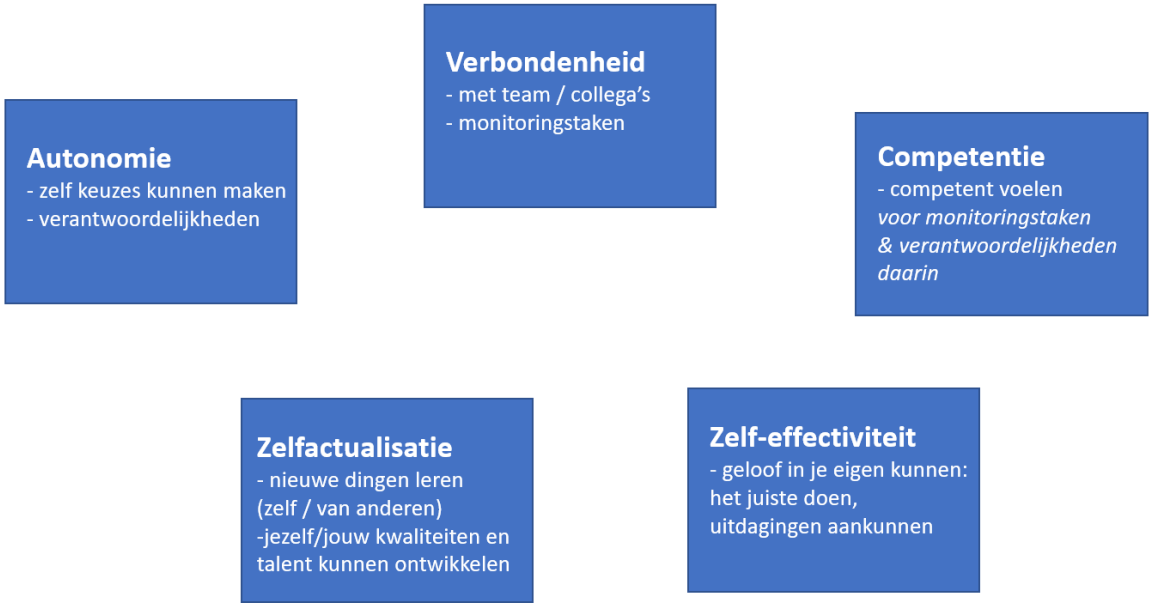
- Welke van de factoren van autonomie (eigen keuzes, verantwoordelijkheden), verwantschap (verbondenheid met collega's, taken), competenties, zelfactualisatie en zelf-effectiviteit, … (andere genoemde factoren) zijn het **meest van belang en welke het minste voor jouw motivatie**?
Dus welke zou je op **plaats 5 t/m 1** zetten, met 5 minst van belang en 1 meest van belang.

-> Kaartjes

- En zijn er bepaalde factoren die **invloed hebben op elkaar**? Of zijn er andere **aspecten van invloed op deze**

factoren?
(->alle mogelijke verbanden nagaan, wat is de aard van de relatie en waarom?).

-> Kaartjes



Onderwijsmodule
Uiteindelijk zou ik ook graag een begin van een onderwijsmodule willen ontwikkelen voor anesthesiemedewerkers over AI. Zou dat jou interesseren? Wanneer? Wat zou je erin willen zien?

Interview Protocol AM3, AM4, AM5

- Heel kort: Wat zijn jouw **taken als AM** in het **monitoren**?
- Horen jullie wel eens wat over AI-ontwikkelingen? Word er **over AI mogelijkheden** gesproken tussen anesthesiemedewerkers onderling / binnen het OK-team?

AI acceptatie
- Welk **beeld** heb je bij AI in het algemeen? En bij AI op de OK?

Als onduidelijk is wat AI kan: kan je zien als een computer die heel veel data heeft, en de data die hij meet: vitale parameters kan hij vergelijken met eerdere data en ook patiëntgegevens (als gewicht, eerdere aandoeningen) daarin meenemen. Bijvoorbeeld als er meerdere operaties geweest zijn waarbij een plotselinge lage vitale waarde met een hoge andere vitale waarde tot iets leidde, dan kan AI waarschuwen dat bepaalde medicatie nodig is of dat je alert moet zijn op iets specifieks.

- Hoe sta jij in het **algemeen tegenover de introductie van AI** op de OK?

- Wat **verwacht je van AI?**
    - **Denk je dat het zal bijdragen aan de effectiviteit van het monitoren?**
    - **Heb je verwachtingen dat het monitoren meer/minder moeite zal gaan kosten?**

- Zou je er wat voor voelen dat **AI kan voorspellen of een patiënt extra medicatie** nodig heeft: sedatie / pijnmedicatie / inotropica / …

- Als die **apparaten** wellicht in de toekomst geheel **autonoom** zouden kunnen werken, dat ze o.b.v. bepaalde metingen zelf de medicatie zouden kunnen aanpassen zonder enige tussenkomst van AM? Hoe kijk je daar tegenaan?
- Welke **apparaten** (of taken in het monitoren) **zou jij verbetering in willen zien**; zou AI hier een bijdrage kunnen leveren? Hoe zie je dit dan voor je?
(Eventueel VB: BIS-monitor, registratie medicatie, alarmen, …)

- Hangt jouw acceptatie van AI ook af van je leidinggevenden / collega's? Zou je het sneller accepteren als zij het accepteren? En vrienden?

Motivatie
(open)- Wat zijn dingen in jouw monitoringstaken die jij **belangrijk vindt voor je motivatie** om die taken te doen?
(a.d.h.v. factoren sturen): Op basis van mijn literatuuronderzoek zijn er bepaalde factoren naar voren gekomen die gerelateerd zijn aan motivatie. Graag wil ik jou vragen in hoeverre deze motivatie factoren ook van invloed zijn op jouw motivatie.
- hoe belangrijk is het voor jouw motivatie dat je
(op schaal: onbelangrijk / enigszins belangrijk / redelijk belangrijk / belangrijk / zeer belangrijk)

Autonomie:
- **autonomie** hebt in het monitoren? Hieronder valt: **eigen keuzes kunnen en mogen maken & verantwoordelijkheden.**

Verbondenheid:
- **je verbonden voelt met je team/collega's** tijdens het monitoren?
- **je verbonden voelt met de taken die je doet** tijdens het monitoren?

Competentie
- het **gevoel hebt dat je bepaalde competenties hebt (je competent voelen)** die benodigd zijn voor je monitoringstaken en verantwoordelijkheden daarin?

Zelfactualisatie
- nieuwe dingen kunt **leren?** En dingen kunt **leren van anderen?**
- **jezelf/jouw kwaliteiten, talenten en vaardigheden** (verder) kunt **ontwikkelen?**

Zelf-effectiviteit:

- gelooft in je eigen kunnen om in je monitoringstaken het juiste te doen, de uitdagingen aan te kunnen?
In hoeverre hebben de volgende punten invloed op jouw geloof in je eigen kunnen?
→ Ja/beetje/niet echt.
- aangemoedigd worden door collega's/complimenten krijgen**?**
- bepaalde **handelingen met succes uitvoeren?**
- andere mensen de taak zien uitvoeren?
- fysiologische opwinding: dat je de spanning voelt, je bloeddruk en hartslag omhoog gaat etc.?

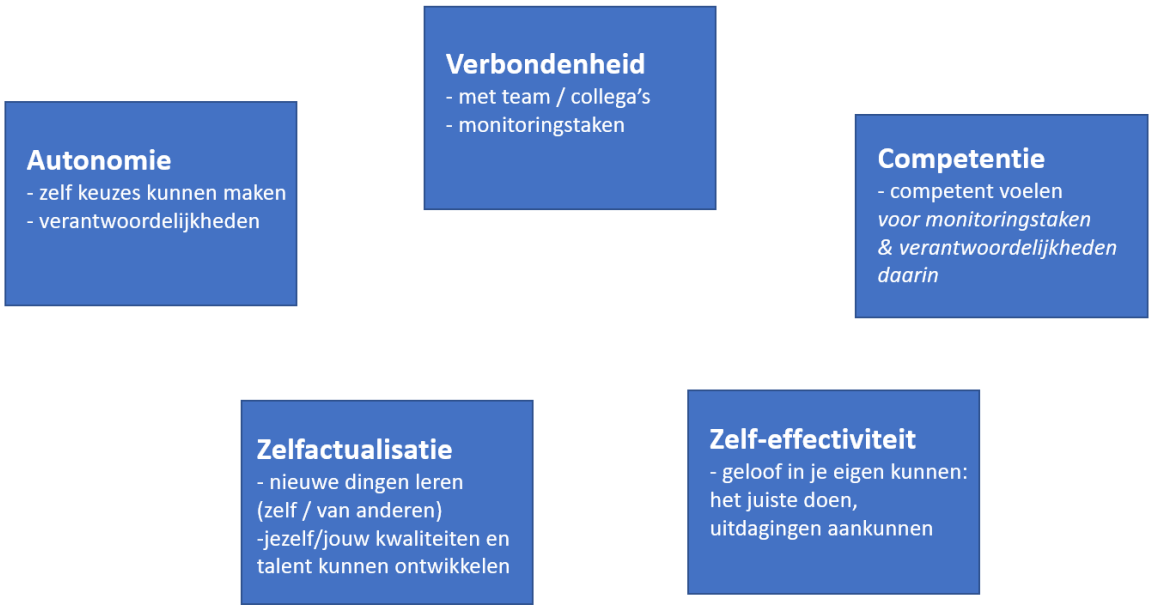
(open)- Zijn er na deze voorbeelden nog **andere aspecten die niet genoemd zijn die jij belangrijk vindt voor je motivatie**?

- Welke van de factoren van autonomie (eigen keuzes, verantwoordelijkheden), verwantschap (verbondenheid met collega's, taken), competenties, zelfactualisatie en zelf-effectiviteit, … (andere genoemde factoren) zijn het **meest van belang en welke het minste voor jouw motivatie**?
Dus welke zou je op **plaats 5 t/m 1** zetten, met 5 minst van belang en 1 meest van belang.

-> Kaartjes

- En zijn er bepaalde factoren die **invloed hebben op elkaar**? Of zijn er andere **aspecten van invloed op deze factoren**?
(->alle mogelijke verbanden nagaan, wat is de aard van de relatie en waarom?).

-> Kaartjes



Onderwijsmodule

Uiteindelijk zou ik ook graag een begin van een onderwijsmodule willen ontwikkelen voor anesthesiemedewerkers over AI. Zou dat jou interesseren? Wanneer? Wat zou je erin willen zien?

Interview Protocol AM6

- Heel kort: Wat zijn jouw **taken als AM** in het **monitoren**?
&
- Met welke **apparaten** heb je allemaal te maken **tijdens het monitoren**?
(beademingsapparatuur, medicatie, …)

- Horen jullie wel eens wat over AI-ontwikkelingen? Word er **over AI mogelijkheden** gesproken tussen anesthesiemedewerkers onderling / binnen het OK-team?

AI acceptatie
- Welk **beeld** heb je bij AI in het algemeen? En bij AI op de OK?

Als onduidelijk is wat AI kan: kan je zien als een computer die heel veel data heeft, en de data die hij meet: vitale parameters kan hij vergelijken met eerdere data en ook patiëntgegevens (als gewicht, eerdere aandoeningen) daarin meenemen. Bijvoorbeeld als er meerdere operaties geweest zijn waarbij een plotselinge lage vitale waarde met een hoge andere vitale waarde tot iets leidde, dan kan AI waarschuwen dat bepaalde medicatie nodig is of dat je alert moet zijn op iets specifieks.

- Hoe sta jij in het **algemeen tegenover de introductie van AI** op de OK?

- Wat **verwacht je van AI?**
    - **Denk je dat het zal bijdragen aan de effectiviteit van het monitoren?**
    - **Heb je verwachtingen dat het monitoren meer/minder moeite zal gaan kosten?**

- Zou je er wat voor voelen dat **AI kan voorspellen of een patiënt extra medicatie** nodig heeft: sedatie / pijnmedicatie / inotropica / …

- Als die **apparaten** wellicht in de toekomst geheel **autonoom** zouden kunnen werken, dat ze o.b.v. bepaalde metingen zelf de medicatie zouden kunnen aanpassen zonder enige tussenkomst van AM? Hoe kijk je daar tegenaan?
- Welke **apparaten** (of taken in het monitoren) **zou jij verbetering in willen zien**; zou AI hier een bijdrage kunnen leveren? Hoe zie je dit dan voor je?
(Eventueel VB: BIS-monitor, registratie medicatie, alarmen, …)

- Hangt jouw acceptatie van AI ook af van je leidinggevenden / collega's? Zou je het sneller accepteren als zij het accepteren? En vrienden?

Motivatie
(open)- Wat zijn dingen in jouw monitoringstaken die jij **belangrijk vindt voor je motivatie** om die taken te doen?
(a.d.h.v. factoren sturen): Op basis van mijn literatuuronderzoek zijn er bepaalde factoren naar voren gekomen die gerelateerd zijn aan motivatie. Graag wil ik jou vragen in hoeverre deze motivatie factoren ook van invloed zijn op jouw motivatie.
- hoe belangrijk is het voor jouw motivatie dat je
(op schaal: onbelangrijk / enigszins belangrijk / redelijk belangrijk / belangrijk / zeer belangrijk)

Autonomie:
- **autonomie** hebt in het monitoren? Hieronder valt: **eigen keuzes kunnen en mogen maken & verantwoordelijkheden.**

Verbondenheid:
- **je verbonden voelt met je team/collega's** tijdens het monitoren?
- **je verbonden voelt met de taken die je doet** tijdens het monitoren?

→ voel je je verbonden met collega's / team? En voel je je verbonden met de monitoringstaken?

Competentie

- het **gevoel hebt dat je bepaalde competenties hebt (je competent voelen)** die benodigd zijn voor je monitoringstaken en verantwoordelijkheden daarin?

Zelfactualisatie

- nieuwe dingen kunt **leren?** En dingen kunt **leren van anderen?**

- jezelf/jouw kwaliteiten, talenten en vaardigheden (verder) kunt **ontwikkelen?**

Zelf-effectiviteit:

- gelooft in je eigen kunnen om in je monitoringstaken het juiste te doen, de uitdagingen aan te kunnen?

In hoeverre hebben de volgende punten invloed op jouw geloof in je eigen kunnen?

→ Ja/beetje/niet echt.

- aangemoedigd worden door collega's/complimenten krijgen**?**

- bepaalde **handelingen met succes uitvoeren?**

- andere mensen de taak zien uitvoeren?

- fysiologische opwinding: dat je de spanning voelt, je bloeddruk en hartslag omhoog gaat etc.?

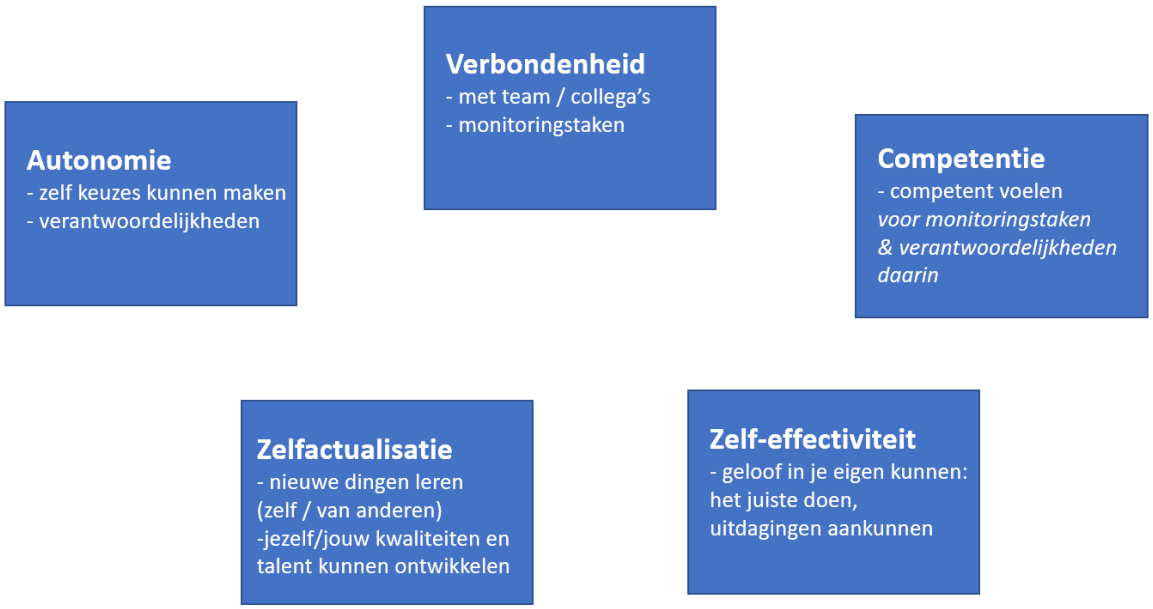
(open)- Zijn er na deze voorbeelden nog **andere aspecten die niet genoemd zijn die jij belangrijk vindt voor je motivatie**?

- Welke van de factoren van autonomie (eigen keuzes, verantwoordelijkheden), verwantschap (verbondenheid met collega's, taken), competenties, zelfactualisatie en zelf-effectiviteit, … (andere genoemde factoren) zijn het **meest van belang en welke het minste voor jouw motivatie**?
Dus welke zou je op **plaats 5 t/m 1** zetten, met 5 minst van belang en 1 meest van belang.

-> Kaartjes

- En zijn er bepaalde factoren die **invloed hebben op elkaar**? Of zijn er andere **aspecten van invloed op deze factoren**?
(->alle mogelijke verbanden nagaan, wat is de aard van de relatie en waarom?).

-> Kaartjes



- Op welke factoren denk je dat AI positief of negatief van invloed kan zijn (voor jou)? Hoe (positief/negatief), en waarom?
    - Als AI suggesties geeft / risicofactoren voorspelt en waarschuwt
    - Als AI autonoom extra medicatie bij zou geven o.b.v. de metingen

Onderwijsmodule

Uiteindelijk zou ik ook graag een begin van een onderwijsmodule willen ontwikkelen voor anesthesiemedewerkers over AI. Zou dat jou interesseren? Wanneer? Wat zou je erin willen zien?

Interview Protocol AM7

Introductie OK & taken

- Bij jouw **monitoringstaken** als AM: welke metingen doe je dan allemaal? (Check: ECG, bloeddruk, zuurstofsaturatie, lichaamstemperatuur, BIS, gassen: O_2 en CO_2; welke drukken precies? + flow + aantal liter etc., neuromusculaire relaxatie; hoe precies? // vocht/plassen, bloedverlies, …)
- En met welke **apparaten** heb je dan allemaal te maken **tijdens het monitoren**? (Philips monitor, pulsoxymeter, beademingsmachine, computer om documentatie te registeren, …)

- Klopt het dat de BIS-monitor **achterloopt in tijd**? En de pulsoxymeter?

- Zijn er andere factoren/aspecten die ook jouw monitoringstaken **complexer** maken (dus complexer dan puur de taak op zich uitvoeren)?
Speelt **striktere regelgeving en protocollering** van de afgelopen jaren hier een rol in? Ervaar je **tijdsdruk**?
Welke rol speelt **evidence based practice** hierin?

- Horen jullie wel eens wat over AI-ontwikkelingen? Word er **over AI mogelijkheden** gesproken tussen anesthesiemedewerkers onderling / binnen het OK-team?

AI acceptatie

- Welk **beeld** heb je bij AI in het algemeen? En bij AI op de OK?

Definitie AI: kan je zien als een computer die heel veel data heeft, en de data die hij meet: vitale parameters kan hij vergelijken met eerdere data en ook patiëntgegevens (als gewicht, eerdere aandoeningen) daarin meenemen. Bijvoorbeeld als er meerdere operaties geweest zijn waarbij een plotselinge lage vitale waarde met een hoge andere vitale waarde tot iets leidde, dan kan AI waarschuwen dat bepaalde medicatie nodig is of dat je alert moet zijn op iets specifieks.

Een kleine opmerkelijke verandering in de bloeddruk lijn kan herkend worden door AI, waardoor gewaarschuwd kan worden voor een event (als ernstige bloeddrukdaling) die over zeg 10 minuten plaats gaat vinden.

- Hoe sta jij in het **algemeen tegenover de introductie van AI** op de OK?

- Wat **verwacht je van AI?**
  - Denk je dat het zal bijdragen aan de effectiviteit van het monitoren?
  - Heb je verwachtingen dat het gebruik van AI moeite zal kosten? En zal het monitoren meer/minder moeite gaan kosten?

- Zou je er wat voor voelen dat **AI kan voorspellen of een patiënt extra medicatie** nodig heeft of dat er een event gaat optreden over een bepaalde tijd?

  - hoe denk je over **alarmmoeheid**? En de invloed van AI hierop?
  - ben je bang dat je minder oplettend zal gaan worden? En minder zelf gaat nadenken? Of kan het juist ervoor zorgen dat je meer gaat beredeneren o.b.v. wat AI voorspelt?
  - zie je het als een samenwerking met AI?
  - Hoe ervaar je **werkdruk en personeelstekort** in jouw baan?
  Zou **AI** de werkdruk kunnen **verlagen**?

(- Als die **apparaten** wellicht in de toekomst geheel **of deels autonoom** zouden kunnen werken, dat ze o.b.v. bepaalde metingen zelf de medicatie zouden kunnen aanpassen zonder enige tussenkomst van AM? Hoe kijk je daar tegenaan?)
- Welke **apparaten** (of taken in het monitoren) **zou jij nog verbetering in willen zien**; zou AI hier een bijdrage kunnen leveren? Hoe zie je dit dan voor je?
(Eventueel VB: BIS-monitor, bepaalde metingen?)

- Hangt jouw acceptatie van AI ook af van je leidinggevenden / collega's? Zou je het sneller accepteren als zij het accepteren? En vrienden?

Motivatie

(open)- Wat zijn dingen in jouw monitoringstaken die jij **belangrijk vindt voor je motivatie** om die taken te doen?

(a.d.h.v. factoren sturen): Op basis van mijn literatuuronderzoek zijn er bepaalde factoren naar voren gekomen die gerelateerd zijn aan motivatie. Graag wil ik jou vragen in hoeverre deze motivatie factoren ook van invloed zijn op jouw motivatie.

- hoe belangrijk is het voor jouw motivatie **in het monitoren** dat je

(op schaal: onbelangrijk / enigszins belangrijk / redelijk belangrijk / belangrijk / zeer belangrijk)

Autonomie:

- **autonomie** hebt in het monitoren? Hieronder valt: **eigen keuzes kunnen en mogen maken & verantwoordelijkheden.**

Verbondenheid:

- je verbonden voelt met je team/collega's tijdens het monitoren?

- **je verbonden voelt met de taken die je doet** tijdens het monitoren?

→ voel je je verbonden met collega's / team? En voel je je verbonden met de monitoringstaken?

Competentie

- het **gevoel hebt dat je bepaalde competenties hebt (je competent voelen)** die benodigd zijn voor je monitoringstaken en verantwoordelijkheden daarin?

Zelfactualisatie

- nieuwe dingen kunt **leren?** En dingen kunt **leren van anderen?**

- jezelf/jouw kwaliteiten, talenten en vaardigheden (verder) kunt **ontwikkelen?**

Zelf-effectiviteit:

- gelooft in je eigen kunnen om in je monitoringstaken het juiste te doen, de uitdagingen aan te kunnen?

In hoeverre hebben de volgende punten invloed op jouw geloof in je eigen kunnen?

→ Ja/beetje/niet echt.

- aangemoedigd worden door collega's/complimenten krijgen**?**

- bepaalde **handelingen met succes uitvoeren?**

- andere mensen de taak zien uitvoeren?

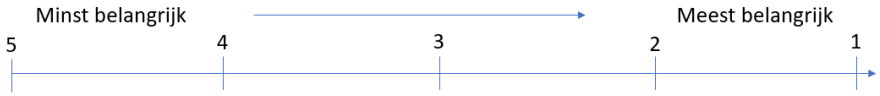
- fysiologische opwinding: dat je de spanning voelt, je bloeddruk en hartslag omhoog gaat etc.?

(open)- Zijn er na deze voorbeelden nog **andere aspecten die niet genoemd zijn die jij belangrijk vindt voor je motivatie**?

- Welke van de factoren van autonomie (eigen keuzes, verantwoordelijkheden), verwantschap (verbondenheid met collega's, taken), competenties, zelfactualisatie en zelf-effectiviteit, … (andere genoemde factoren) zijn het **meest van belang en welke het minste voor jouw motivatie**?

Dus welke zou je op **plaats 5 t/m 1** zetten, met 5 minst van belang en 1 meest van belang.

-> Kaartjes



Autonomie
- zelf keuzes kunnen maken
- verantwoordelijkheden

Verbondenheid
- met team / collega's
- monitoringstaken

Competentie
- competent voelen
voor monitoringstaken
& verantwoordelijkheden
daarin

Zelfactualisatie
- nieuwe dingen leren
(zelf / van anderen)
-jezelf/jouw kwaliteiten en talent
kunnen ontwikkelen

Zelf-effectiviteit
- geloof in je eigen kunnen: het
juiste doen, uitdagingen
aankunnen

- En zijn er bepaalde factoren die **invloed hebben op elkaar**? Of zijn er andere **aspecten van invloed op deze factoren**?
(->alle mogelijke verbanden nagaan, wat is de aard van de relatie en waarom?).

-> Kaartjes

Verbondenheid
- met team / collega's
- monitoringstaken

Autonomie
- zelf keuzes kunnen maken
- verantwoordelijkheden

Competentie
- competent voelen
voor monitoringstaken
& verantwoordelijkheden
daarin

Zelfactualisatie
- nieuwe dingen leren
(zelf / van anderen)
-jezelf/jouw kwaliteiten en
talent kunnen ontwikkelen

Zelf-effectiviteit
- geloof in je eigen kunnen:
het juiste doen,
uitdagingen aankunnen

- Op welke **factoren** denk je dat **AI positief of negatief van invloed kan zijn** (voor jou)? Hoe (positief/negatief), en **waarom**?
    - Als AI suggesties geeft / risicofactoren voorspelt en waarschuwt
    (- Als AI autonoom extra medicatie bij zou geven o.b.v. de metingen)

Onderwijsmodule
Uiteindelijk zou ik ook graag een begin van een onderwijsmodule willen ontwikkelen voor anesthesiemedewerkers over AI.

- Zou dat jou interesseren? Wanneer? Wat zou je erin willen zien? Hoe diepgaand wil je over AI leren? En over de uitlegbaarheid van AI: waarom hij bepaalde voorspellingen maakt?
- Zou je ook iets willen leren over jouw motivatie en hoe AI die zou kunnen beïnvloeden?

- Hoe ziet jullie **bijscholing** er nu uit?

Appendix C) Informed consent form

Toestemmingsformulier / informed consent

November 2021 – May 2022

Afstudeeronderzoek Karlijn Joosten – Artificiële Intelligentie op de OK, TU Delft

- Ik heb de informatie(brief) gelezen. Ik kon vragen stellen. Mijn vragen zijn voldoende beantwoord. Ik had genoeg tijd om over deelname te beslissen.

- Ik weet dat meedoen vrijwillig is en dat ik mijn toestemming kan intrekken op ieder moment van het onderzoek. Daarvoor hoef ik geen reden te geven.

- Ik weet dat als ik mij terugtrek, mijn gegevens tot dat moment gebruikt kunnen worden, tenzij ik ook vraag om de reeds verzamelde gegevens te wissen.

- Ik geef toestemming voor het verzamelen, bewaren en gebruiken van mijn gegevens voor de beantwoording van de onderzoeksvraag in dit onderzoek.

- Ik geef toestemming voor hergebruik van mijn gegevens na dit onderzoek voor nu nog onbekend onderzoek dat binnen het vakgebied van het (bio)medisch-onderwijs onderzoek valt. Hierbij worden de erkende ethische normen voor deze vorm van wetenschappelijk onderzoek in acht genomen.

- Ik geef
  □ wel
  □ geen
  toestemming voor hergebruik van mijn gegevens na dit onderzoek voor nu nog onbekend onderzoek dat binnen het vakgebied
  van het (bio)medisch-onderwijs onderzoek valt.

- Ik weet dat alleen ter controle van de wetenschappelijk integriteit van het onderzoek sommige mensen toegang tot mijn verzamelde gegevens kunnen krijgen.

- Ik kan mijn gegevens inzien en volledige inzage krijgen in de wijze waarop mijn gegevens worden verwerkt en bewaard.

- Ik geef
  □ wel
  □ geen
  toestemming om mij na dit onderzoek opnieuw te benaderen voor vervolgonderzoek aansluitend op deze studie.

- Ik wil meedoen aan dit onderzoek.

Naam deelnemer:
Handtekening: Datum: X / X / 202X

---

of

☐ Ik ga akkoord met deelname aan dit onderzoek

Ik, de onderzoeker, verklaar dat ik deze deelnemer volledig heb geïnformeerd over het genoemde onderzoek.
Als er tijdens het onderzoek informatie bekend wordt die de toestemming van de deelnemer zou kunnen beïnvloeden, dan breng ik hem/haar daarvan tijdig op de hoogte.

Naam onderzoeker (of diens vertegenwoordiger): Karlijn Joosten
Handtekening: Datum: X / X / 202X

Appendix D) Coding tree of semi-structured interviews

Figure D.1. Coding tree of semi-structured interviews (Own visualisation).

Appendix E) Taxonomy of Bloom table with verbs for learning goals

The Taxonomy of Bloom with a table with verbs that correspond to the different order thinking skills, and can be used for the construction of learning goals (Leidse Onderwijs Instellingen, n.d.). It should be noted that this is not the revised taxonomy of Bloom, and therefore the verbs used for the higher order thinking skills of synthesising and evaluating do not correspond with the higher order thinking skills as described in the Theoretical Framework (Chapter 2).

Table E.1. Taxonomy of Bloom and verbs that correspond to the different order thinking skills.

Taxonomie van Bloom					
Lagere orde denkvaardigheden			**Hogere orde denkvaardigheden**		
K **Kennis**	**B** **Begrip**	**T** **Toepassen**	**A** **Analyseren**	**S** **Synthetiseren**	**E** **Evalueren**
Ophalen van adequate informatie, variërend van feiten tot complete theorieën	Adequate betekenis geven aan informatie	Gebruiken van kennis, feiten, technieken, regels in nieuwe en concrete situaties	Opdelen van informatie in onderdelen zodat de structuur kan worden begrepen en bestudeerd	Ontwikkelen van nieuwe ideeën, oplossingen, producten met behulp van het geleerde	Beoordelen van de waarde van iets in relatie tot een bepaald doel

	K	B	T	A	S	E
aanduiden		x				
aangeven	x	x	x	x	x	x
aangeven van grote lijnen, belang, essentie		x				
aangeven van onderdelen		x				
aangeven van verschillen/ overeenkomsten/ tegenstrijdigheden		x				
aangeven van grenzen, hiaten, fouten e.d.			x	x		
aangeven van gevolg, consequentie, effect, relatie, verband				x		
aangeven van hoofd- en bijzaken				x		

	K	B	T	A	S	E
aangeven van patronen				x		
aangeven van voorwaarden, condities				x		
aangeven van alternatieven, verbeterpunten, verbeteringen					x	
aangeven van eigen standpunt, mening, oordeel, argumenten						x
aanpassen					x	
aantonen		x	x			
aanvullen		x				
adviseren				x	x	x
afkeuren				x		x

	K	B	T	A	S	E
afleiden		x		x	x	x
aflezen		x				
afmeten		x				
afwegen				x		x
afwegingen maken				x		x
alternatieven voorleggen/ formuleren/aangeven					x	x
analyseren				x		
argumenteren						x
artikel schrijven					x	
beargumenteren						x
becommentariëren				x		x
bedenken					x	
bedenken van metaforen					x	
bedenken van een product/dienst					x	
behandelen			x			
bekritiseren						x
belang aangeven		x				
belangen afwegen				x		x
benoemen	x					
beoordelen van X a.d.h.v/m.b.v. Y						x
beproeven			x	x		
berekenen			x			
beschrijven	x					
beslissen						x

	K	B	T	A	S	E
besluiten/besluit nemen						x
bestempelen		x				
bewaken			x			
bewijs geven van		x				
bewijzen dat			x	x		x
bij elkaar zetten		x				
bijdragen			x			
categoriseren				x		
checklist opstellen				x		
classificeren				x		
combineren		x			x	
commentaar geven						x
componeren					x	
concluderen						x
conclusie trekken						x
consequenties aangeven				x		
construeren					x	
controleren			x	x		
creëren van voorwaarden/ condities					x	
deconstrueren				x		
definitie van een begrip geven	x					
demonstreren			x			
discussiëren				x		x
effect(en) aangeven				x		

	K	B	T	A	S	E
eigen standpunt geven						x
essentie aangeven		x				
evaluatie opstellen/ schrijven						x
evalueren						x
experiment uitvoeren			x			
experimenteren					x	
extrapoleren					x	x
formuleren		x	x	x	x	
formuleren van vragen			x			
formuleren van een hypothese				x		
formuleren van een scenario					x	
formuleren van een oplossing					x	
fouten aangeven				x		
fouten opsporen				x		
gesprekken voeren			x			
gevolg(en) aangeven				x		
goedkeuren				x		x
grafiek (diagram, tabel, spreadsheet e.d.) aflezen		x				
grafiek (diagram, tabel, spreadsheet e.d.) maken				x		
grenzen aangeven				x		
groeperen		x	x	x		
herformuleren					x	
herhalen	x					

	K	B	T	A	S	E
herkennen	x	x				
hiaten aangeven				x		
hoofd- en bijzaken aangeven				x		
hypothese opstellen/ formuleren					x	
illustreren		x				
imiteren	x					
in een gegeven eenduidige volgorde plaatsen	x					
in eigen woorden weergeven		x				
in symbolen weergeven		x				
instructie opstellen					x	
instrueren			x	x		x
integreren					x	
inventariseren	x					
karakteriseren		x				
kern aangeven		x				
keuze verantwoorden/ onderbouwen						x
kiezen		x	x			x
kritiek geven						x
kritisch doorlichten						x
leidinggeven aan					x	x
maken → gebruik bij voorkeur: opstellen, ontwerpen, ontwikkelen			x	x	x	

	K	B	T	A	S	E
maken van bv. diagram, tabel, spreadsheet etc.				x		x
maken van bv. model, plattegrond, opzet, tekening etc.					x	
mening geven						x
met eigen woorden vertellen		x				
meten		x				
modelleren			x		x	
motiveren				x	x	x
nadoen	x					
namaken (bv. model, plattegrond etc.)		x	x			
natekenen	x					
navertellen	x					
nemen van een besluit/beslissing						x
noemen (zie ook aangeven)	x					
omzetten		x	x			
onderbouwen				x		x
onderdelen aangeven		x				
onderhandelen						x
onderhouden			x			
onderkennen	x					
onderscheiden		x		x		
ondersteunen			x	x	x	x
onderstrepen	x					
onderzoeken				x		

	K	B	T	A	S	E
ontleden				x		
ontwerpen					x	
ontwikkelen van concrete zaken, bv.: programma, test					x	
oordeel geven						x
oorzaak/gevolg opsporen/aangeven				x		
opbouwen					x	
opdracht geven			x			
opdracht uitvoeren			x			
oplossen problemen met gebruik van standaard-oplossingen					x	
oplossen problemen waar geen standaardoplossing voor is				x	x	x
oplossen vraagstuk m.b.v. een methode, techniek, algoritme			x			
opsommen	x					
opstellen			x	x	x	
opstellen van vragen			x			
opstellen van een planning			x			
opstellen van een hypothese, checklist				x		
opstellen van een tabel, diagram, spreadsheet				x		x
opstellen van een plan, ontwerp, rapport, instructie, verslag, voorstel					x	

	K	B	T	A	S	E
opstellen van een evaluatie, reflectie						x
opzet maken voor					x	
opzetten			x	x	x	
opzoeken		x				
ordenen		x	x	x		
organiseren			x	x	x	
overleggen				x	x	x
overzicht geven van			x			
overeenkomsten/ verschillen aangeven/ (be)noemen		x		x		
patroon beschrijven/ aangeven				x		
perspectief wisselen						x
plan opstellen (bv. communicatieplan, kwaliteitsplan, bestemmingsplan etc.)					x	
plannen			x			
planning opstellen			x			
presentatie maken			x			
presenteren			x			
prioriteiten stellen				x		
problemen oplossen met gebruik van standaard-oplossingen					x	
problemen oplossen waar nog geen standaardoplossing voor is				x	x	x
procedure kiezen en volgen			x			

	K	B	T	A	S	E
procedure of instructie uitvoeren			x			
produceren			x		x	
rapport(age) opstellen					x	
rapporteren			x			
rechtvaardigen						x
reflecteren						x
reflectie schrijven/ opstellen						x
relateren				x		
relatie/verband leggen				x		
reproduceren	x					
rol spelen			x			
rubriceren		x	x	x		
samenstellen			x		x	
samenvatten		x	x			
samenvatting schrijven			x			
scenario's bedenken					x	x
schatten			x			
schema's maken, schematiseren		x				
schrijven van een artikel, verslag, voorstel (zie ook: opstellen)					x	
schrijven van een samenvatting			x			
selecteren	x	x	x	x		
signaleren		x				
simulatie spelen			x			

	K	B	T	A	S	E
specificeren		x				
spelen rol, simulatie			x			
structureren				x		
synthese maken					x	
tabel maken		x				
tegenargumenten aangeven/noemen		x	x			x
tegenstrijdigheden aanwijzen/aangeven/ noemen		x				
tekenen	x	x				
tekeningen uitleggen/ toelichten/verklaren		x				
testen			x			
toelichten		x				
toepassen			x			
toetsen						x
tot stand brengen					x	
typeren		x				
uit elkaar houden	x	x				
uitdrukken		x				
uitkiezen		x				
uitleggen		x				
uitvinden					x	
uitvoeren			x			
vaststellen		x				
veranderen			x			
verantwoorden				x		x

	K	B	T	A	S	E
verband/relatie leggen/aangeven				x		
verbeterpunten/ verbeteringen aangeven					x	
verdedigen (standpunt, stelling etc.)				x		x
verfijnen		x	x	x	x	
vergelijken		x	x	x		x
verifiëren				x		x
verklaren		x		x		
verschillen/ overeenkomsten noemen/aangeven		x				
verslag doen van			x			
verslag opstellen/ maken over			x		x	
vertegenwoordigen			x			
vertellen		x				
vervangen		x				
verwijzen		x				
verwoorden/onder woorden brengen		x				
verzamelen		x				
visualiseren					x	
voeren van gesprekken			x			
volgorde aangeven		x				
voorbeelden noemen		x				
voorbereiden		x	x			
voorkeur aangeven						x
voorspellen					x	

	K	B	T	A	S	E
voorspelling doen					x	
voorstel doen					x	
vormgeven			x			
vraagstuk oplossen			x			
vragen opstellen			x			
waarderen						x
weergeven	x					
weergeven in eigen woorden		x				
weergeven in een tekening, schema, symbolen, tabel		x				
zelfstandig optreden				x	x	x

Appendix F) Visualisation of relations between motivational factors as identified by the anesthesia assistants

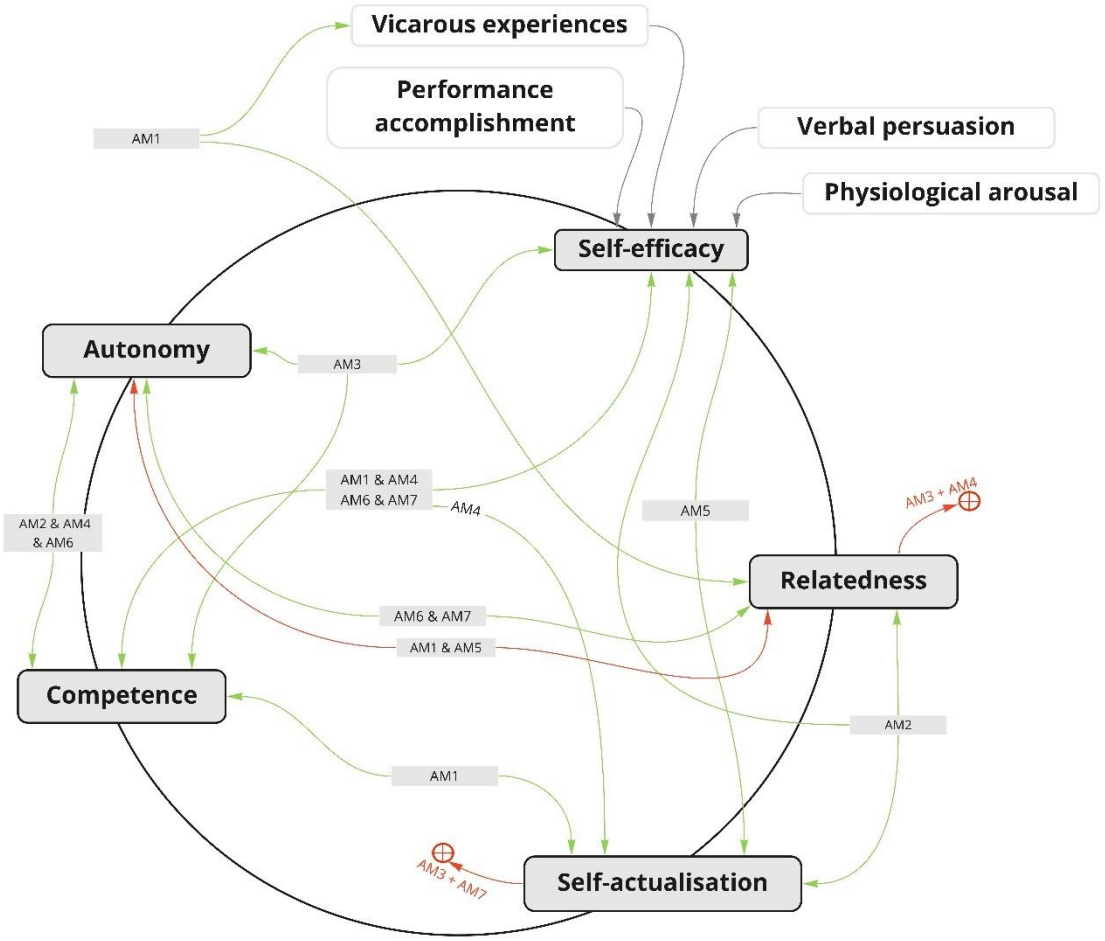


Figure F.1. Visualisation of the relations between the motivational factors as identified by the anesthesia assistants. (Own visualisation). Which relations are identified by which anesthesia assistant is visualised with the codes for the anesthesia assistants on the lines. Green lines indicate that there is a relation identified, red lines identify that no relation is identified by that specific anesthesia assistant. The red cross indicates that this motivational factor was seen as standing alone, so non-related, by those anesthesia assistants. This figure indicates that there are relations between the different motivational factors, meaning that negative or positive impact on one of the motivational factors also impacts other motivational factors.