

# Intraoperative Monitoring from the Nurse Anaesthetist's Perspective, a Qualitative Study



Jildenstål P\*, Warrén Stomberg M and Jakobsson JG

<sup>1</sup>Department of Anaesthesiology, Surgery & Intensive Care Medicine, Sahlgrenska University Hospital of Gothenburg & University of Gothenburg/The Sahlgrenska Academy Institute of Health and care Sciences, Sweden

<sup>2</sup>University of Gothenburg/The Sahlgrenska Academy Institute of Health and care Sciences, Sweden

<sup>3</sup>Department of Anaesthesia & Intensive Care, Danderyds University Hospital, Sweden

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**\*Corresponding author:** Jildenstål Pether, Department of Anaesthesiology, surgery & Intensive Care Medicine, Sahlgrenska University Hospital of Gothenburg & University of Gothenburg/The Sahlgrenska Academy Institute of Health and care Sciences, Gothenburg, Sweden, Tel: 0046760266658; Email: [pether.jildenstal@gu.se](mailto:pether.jildenstal@gu.se)

## Abstract

Monitoring is essential for safe anaesthesia to reduce the occurrence of adverse events by early detection of deviations in the patient's condition. Changes in vital parameters are the basis of early warning signs but needs to be put in a context. The integration of patients' preoperative physiology, medical history, the surgical trauma, and anaesthetic drugs use is complex. A key part of the nurse anaesthetist's professional work is to ensure that the patient is in appropriate depth of anaesthesia during the entire clinical course and that homeostasis is secured. The aim of the present study was to describe nurse anaesthetists' monitoring and assessment of patients undergoing general anaesthesia, focusing on physiological indicators of pain and depth of anaesthesia. An additional aim was to relate these findings to previous findings about intraoperative monitoring and assessment.

**Method:** This is a qualitative semi-structured interview based study with nurse anaesthetists conducted in April 2017. Eight nurse anaesthetists working full for more than five years in western Sweden were interviewed.

**Results:** The nurse anaesthetists' emphasize their value by having an integrated overview of the individual patient. Combining the patients' medical history, pre-existing status and individual intraoperative responses to anaesthesia and surgery, monitored as well as clinical. The nurse anaesthetist role subsequently being to provide and ensure adequate depth of anaesthesia, assure no experience of pain and maintaining basic homeostasis. They found that available basic monitoring modalities are sufficient and expressed no need for further monitoring techniques. Clinical work experience provides the main basis for their skill.

**Conclusion:** The nurse anaesthetists studied were confident with their skill in integrating patient baseline information and monitoring of vital signs for the provision of effective and safe anaesthesia. There is however room for further studies to gain further in depth insight to the nurse anaesthetist assessment and decision process.

**Keywords :** Nurse Anaesthetist; Depth of Anaesthesia; Pain; Monitoring of vital signs

## Introduction

Anaesthesia, is the umbrella description of drug induced state of no sensations and absence of motor response to noxious stimuli. It is essential to have adequate surveillance and control of the patient to secure maintenance of homeostasis. Adequate monitoring is essential for safe anaesthesia reduces the risk of adverse events by early detection of deviations in the patient's condition [1]. Monitoring include a series of parameters. Basic vital variables; heart rate, blood pressure, and oxygen saturation are basic, and may be sufficient during stable regional block and shorter general anaesthetic procedures in health patients. Additional monitoring of respiration, respiratory rate, end-tidal carbon dioxide are minimal requirements during more extensive general anaesthesia. Monitoring of inspired and end-tidal oxygen

increases safety, avoiding hypoxic gas mixture. Measuring anaesthetic gas has also become standard of care during inhaled general anaesthesia. There are also monitors assessing the effect on the brain, so called brain monitors as the BIS-monitor (BIS monitor, COVIDIEN, Dublin, Ireland). The EEG-based depth of anaesthesia monitors may facilitate the titration of depth of anaesthesia especially in the fragile patient [2,3].

During anaesthetic delivery, the patient, the continuous monitoring and the anaesthetic staff should form a loop, "feedback system". The monitored information and the intraoperative responses to administered drugs are evaluated in the context of the surgical procedure and patient's health history. A series of factors are integrated to assess the individual patient in real time [1].

The goal is to balance the anaesthesia, dose the components used and balance the depth of anaesthesia and nociceptive responses evoked by surgery. A key part of the nurse anaesthetist's task is to monitor a patient undergoing general anaesthesia, and to analyse the monitored parameters to ensure that the patient is safe and in an appropriate depth of anaesthesia, adequately unconscious, muscle relaxed and pain free. Each individual patient should also be hemodynamical stable; perfusion and oxygenation should be secured. We have in previous studies tried to identify clinical and monitored indicators for pain responses and/or depth of anaesthesia described by nurse anaesthetist [4,5]. It was found that nurse anaesthetists did not distinguish any monitoring modality being entirely specific for either intra-operative depth of anaesthesia or as a physiological pain indicator. There is indeed a huge interest in monitoring and how the integrated assessment of vital signs under general anaesthesia can be further improved [6]. The weighing of different modalities is however delicate. Intraoperative monitoring and anaesthetic drugs have developed immensely during the last decade, thus we found of interest to conduct a study how the nurse anaesthetist handle intraoperative monitoring and assessment.

### Aim

The aim was to describe nurse anaesthetists' monitoring and assessment of patients undergoing general anaesthesia, focusing on physiological indicators of pain and depth of anaesthesia. An additional aim was to relate these findings to previous findings about intraoperative monitoring and assessment [4,5].

### Method

This article is based on a master thesis. Following the ethical approval process of The University of Gothenburg, Sahlgrenska Academy for student's master thesis (SFS 2003:460) semi-structured interviews with eight nurse anaesthetists was conducted in April 2017. Their working experience was full time nurse anaesthetist employment for more than five years in western Sweden. An interview guide was designed inspired of findings from previous studies and related to upgraded literature about intraoperative monitoring [4-5].

An opening question was

- a) Please describe how to assess anaesthesia and pain indicators during general anaesthesia. This open-ended question was followed up by appropriate questions like.
- b) Which monitored variables or clinical signs indicate this. A pilot interview was held with a registered nurse anaesthetist not included in this study, to test the interview guide. No changes needed to be made. Each interview took place in a separate room at the operation theatre, lasted around 20 minutes, and the interviews were recorded and later transcribed word by word. The participants showed interest in the topic and were engaged during the interviews, which contributed to a good communication and comprehensive answers. None of the asked nurse anaesthetists declined participation in the study.

The study met the ethical principles in the Declaration of Helsinki [7].

### Analysis

The data material gathered was analysed using content analysis, followed the steps described by Graneheim and Lundman [8]. The text unit of analysis was read through repeatedly to get an overall perspective. Sentences or phrases that contained similar information relevant to the purpose were marked as meaning units and then coded and grouped into categories that reflected the central message in the interviews. The categories were closely related to the text and form the manifest content. This inductive approach constitutes an unbiased analysis.

### Result

The work experience as nurse anaesthetist among the eight nurses included varied between 6-37 years with an average of 21 years. The main finding in monitoring and assessment during anaesthesia was based on the category Factors of significance for an overall assessment presented in subcategories.

### Patients Baseline Values

Patient's physical baseline values prior to anaesthesia were central to how the nurse anaesthetist assessed the patient's depth of anaesthesia and pain response. The patient's medical history and daily drug consumption also influence the assessment. For example, several drugs may affect pulse and blood pressure, e.g. beta blockers and antihypertensive drugs, which the nurse anaesthetist will consider in their assessment intraoperatively. It was emphasized that each patient was unique, and the anaesthesia course was adapted to the patient's base-line conditions and individual reactions during anaesthesia/surgery more than to general rules.

### Patient Advocacy

Since patients cannot express or defend themselves during general anaesthesia, the nurse anaesthetist felt responsible to advocate the patient. The nurse anaesthetist has an obligation to take an active part in the surgical activity, communicate with the surgeon e.g. prepare for stressful situations, follow blood loss and any unexpected events. The actions for nurse anaesthetist may be obvious when considering the role "speak up for the patients' basic welfare" in the surgical team.

### Clinical as well as Monitored Signs Constitutes the basis for the Assessment

Basic physiological monitored parameters, such as pulse, blood-pressure, ECG, saturation and end-tidal gas concentration, MAC-multiple, were described being important to analyse and put "trust into". The clinical signs were seen as important complement to complete the overall nurse anaesthetist's assessments. Tears in eyes, eyes that squint, dilated pupils was thought to be a sign of pain or insufficient depth of anaesthesia. If the patient had not received muscle relaxed drugs, muscle tone and any signs of movements was integrated to the assessment of the anaesthetic

depth. Increased breathing resistance and changes in ventilation pressure and volume indicate an increased tension of the patient who actually represents the patient responding to the surgical stimulus or having insufficient depth of anaesthesia.

Any change in vital parameters was not only observed but also viewed together with clinical signs to gain an oversight of the situation, whether adjust or observe. In addition to other parameters all participants expressed that the assessment of the patient to a large extent is an intuition and to sense patients' comfort despite details in monitoring. This so-called intuition was considered to be a direct result of accumulated experience; generated knowledge during their professional years of working. Having knowledge and experience about the surgical process performed, gave advance in predicting painful events and to be a step ahead. Recommended technical monitoring equipment was used by all participants. Additional monitors e.g. BIS were used to varying degrees depending on the surgical procedure and the anaesthesia method. In general, it was stated that BIS was a complement tool, but at the same time scepticism to trust only the BIS value was expressed.

### An Overall Assessment

The procedures for assessing the patient were developed individually, and participants scanned the monitors and patient in part unstructured. But all parameters were somehow incorporated to get an overall picture, of the patient's status in order to follow a process and discover changes. High emphasis was placed on the overall impression of a combined picture of all available information from patient's preoperative status, individual monitored and clinical intraoperative responses to anaesthesia and surgery, to give a complete picture. The nurse anaesthetist's interviewed did not miss any further monitoring technique. They felt available base monitoring was "sufficient" to make a complete assessment.

### Discussion

We found that nurse anaesthetists felt confident in their work integrating a series of information and based on knowledge, skill and experience adjust anaesthesia to each individual patient unique need. The nurse anaesthetists see their main task to secure adequate depth of anaesthesia and act as a safe-guard for the patient during anaesthesia/surgery. Basic monitoring and the continuous assessment of the clinical course were considered as adequate for the safe anaesthesia delivery for the ASA 1-2 patient.

This study show similarity with our previous study [4,5] when basic clinical signs, monitored values, the patient's baseline status and unique intraoperative responses is included in the assessment. Anaesthesia is a drug induced state of unconsciousness, suppression of reflexes and responses to pain, thus making the patient unaware and unresponsive to the surgical trauma. The task for the anaesthesia personnel is to adequately balance the dosing of the anaesthetic drugs, avoiding too light and too deep anaesthesia, securing adequate anaesthesia avoiding awareness with recall but also to avoid too deep anaesthesia with potential

depression of hemodynamic performance and prolongation of recovery.

We found that the nurse anaesthetist assessed the vital signs and did put these into the context of base-line values. We did not find that they rated one of vital sign over the other, but tried to combine and assess the vital signs in a composite manner taking base-line values into account. We could not see that there were any explicit set targets, values that should be followed. Target control has become popular and the concept of close loop and target control algorithms is increasingly used in anaesthesia. The benefits vs. risks associated to the clinical use of these automatic systems are however debated [9-11]. The experience from aviation promotes their use and there is increasing evidence that "close loop anaesthesia" is accurate, safe and effective. There are two recent published meta-analyses showing that closed-loop anaesthesia performs as well as manual control but reduce drug usage and facilitate recovery [12-13]. The closed-loop anaesthesia is mainly conducted with intravenous anaesthesia. Merley et al. [14] showed however already in 2000 that a closed loop system worked also with isoflurane as main anaesthetic; however the isoflurane administered via a surging pump controlled by the system. There is also today the possibility to use a not fully closed but automatic system for inhaled agents. Targeted end-tidal gas control is a feature available in many modern anaesthesia work stations. This is not a full close-loop, merely a control of the end-tidal anaesthetic agent control, adjusting fresh gas flow, vaporizer setting to achieve a set anaesthetic agent end-tidal value. The use and trust in target control techniques was not addressed in our study.

Although it is 16 years since a similar study was carried out, it is surprising that similarity in the result is prominent monitoring anaesthetic depth and pain indicators from the nurse anaesthetist's perspective. Despite the technology development nurse anaesthetist today does not request additional technical equipment to monitor adequate anaesthesia. It was found that independently, each monitored variable was found to be rather imprecise predictors of depth of anaesthesia and/or pain indicator. The monitored parameters were seen in a whole to provide a complete adequate picture. This is consistent with previous findings [4,5].

Assessing the anaesthetic depth is complex and it was found in this study that professional knowledge gradually emerges after years of professional experience. This in accordance to [16] who states that reflective practice as experience is a learning tool essential to professional education and excellence. Assessing adequate anaesthesia has been a matter of discussion since many decades. Arthur Ernest Guedel described in 1937 a clinical classification of anaesthetic state based on the use of a sole inhalational anaesthetic agent diethyl ether [16]. The signs of this classical Guedel's classification depended on the eyelash reflex, respiration, eyeball movements, pupillary size, and muscular movements among others. Since then series of scores and techniques have been tested for assessing and secure adequate

anaesthesia. Evans et al described the “Evans score” and compared this to the lower oesophageal contractions [17]. Clinical signs are still the mainstay for monitoring however EEG based techniques have evolved and provide additional information.

The nurse anaesthetists expressed a rather critical view around the BIS monitor. There is a Cochrane Database Systemic review from October 2016 addressing the potential benefit of EEG-based depth-of-anaesthesia monitors, BIS monitoring reducing the risk for wakefulness and/or awareness, recall. This meta-analysis could not prove the EEG based technique superior [18]. The BAG-RECALL research group showed likewise that an end-tidal concentration target 0.7-1.3 MAC was more effective than a BIS target for minimizing the risk for awareness [19]. The benefits of EEG-based intra-operative monitoring may go beyond the intraoperative period. There is a meta-analysis from March 2015 showing that depth of anaesthesia during general anaesthesia influences the incidence of postoperative delirium [20]. Recommendations regarding how anaesthetists shall monitoring the depth of anaesthesia (DOA) to avoid too deep anaesthetic depth has been published from NICE 2012. These recommendations have become essential for avoid postoperative delirium. In a guideline from ESA May 2017 for avoid postoperative delirium, ESA recommending the use of fine tuning EEG DOA monitoring during general anaesthesia [21]. Thus, the use of EEG-based monitoring should be promoted especially in the elderly and or patient at risk for postoperative cognitive side effects.

The goal is indeed not only to secure adequate narcosis but to maintain homeostasis and avoid any adverse events during the perioperative course. There is of course a risk for complications possibly with a fatal outcome. We anaesthetize more elderly, more patients with complex comorbidities and more patients having extensive surgeries. The risk for medical mortality associated to surgery/anaesthesia was studied across Europe and huge differences between countries were found [22]. Age and comorbidity increases risk for both intra and postoperative complications. In this study, we found that participants continuously analyse blood pressure related to the preoperative baseline value and patients' individual responses to surgical intervention. There were no comments of values that should trigger any action. There is a British study assessing the mortality following acute hip fracture repair that could find no difference between anaesthetic technique but showed that reduction in blood pressure had a deleterious effect, The risk of death increased as blood pressure fell: the odds ratio (95% CI) for mortality within five days after surgery was 0.983 (0.973-0.994) for each 5 mmHg intra-operative increment in systolic blood pressure,  $p=0.0016$ , and 0.980 (0.967-0.993) for each mmHg increment in mean pressure,  $p=0.0039$  [23].

The study revealed that the nurse anaesthetists take the medical history and preoperative physiology into their decision process. Preoperative optimization is of importance whenever feasible. There anaesthetic technique has also been a matter of discussion. There is however most sparse evidence to suggest any

difference related to the explicit drug or technique used. The most recent meta-analysis suggests a possible short term beneficial effect from sevoflurane based anaesthesia and the use of epidural technique; Sevoflurane anaesthesia, or epidural combined with general anaesthesia can provide short-term myocardial protective effect in high-risk cardiac patients undergoing intermediate- or high-risk non-cardiac surgeries [24]. We did not include questions around anaesthetic choice.

Overall the nurse anaesthetists emphasize the great responsibility of seeing the unique in each patient, responding to his needs and ensure safe anaesthesia. This is similar to the principle of perioperative advocacy that focus on patients' needs, informing, protecting and speaking up for the patient [25]. There are several limitations. The number of responders is low and further studies are warranted to gain a better view of the nurse anaesthetist patient interaction and their total monitoring process to maintain safe anaesthesia and homeostasis. Results in this study as partly relate to similar studies previously are based on different designs. The technical development is fast and it would likewise be of interest to include topics such as prioritisation, strict protocols, targeted anaesthesia and adoption of close loop techniques.

### Conclusion

The role of nurse anaesthetist providing the anaesthetic care during routine surgery is a unique and important task. The nurse anaesthetist have the role to assess patients preoperative history and incorporate that into the continuous monitoring of the vital signs during anaesthesia, titrating the anaesthetic drugs to maintain homeostasis, secure adequate depth of anaesthesia and safety for the patient during surgery. The combination of basic theoretic skills in anaesthesia, keeping up clinical anaesthesia research and clinical experience are the cornerstones in their clinical work. There is however room for improvement in how to quality ascertain the assessment/decision process.

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### Conflict of Interest

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### Authors' Contributions

MWS has planned the study, prepared the first version of manuscript and PJ and JJ has taken part in the result presentation and writing of manuscript. All authors were involved in manuscript and approved the final version. The RNA students SG and BBJ conducted the interviews and performed a master thesis from the data.



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