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# Digitalization in the operating theatre- an interview study of operating room nurses' and nurse anesthetists' experiences in Norway

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## Abstract

**Background** Digitalization in the health sector requires adaptive change in human attitudes and skills. The operating theatres have been introduced to digital innovations through centuries. The aim of this study was to explore operating room (OR) nurses' and Nurse Anesthetists' (NAs) experiences with digitalization in the operating theatre.

**Methods** The study had a qualitative design, using individual interviews with OR nurses and NAs at a Norwegian hospital. Data were analyzed using reflexive thematic analysis in-line with recommendations from Braun & Clarke.

**Results** Two themes were identified, namely (1) Impacting the work processes, and (2) Implications for patient safety. The OR nurses and NAs experienced that digitalization impacted on their work processes positively through making these smoother, but also negatively making the work processes vulnerable for disruptions, leading to a need for parallel actions. Digitalization was experienced to positively impact patient safety for example through making information more accessible. However, digital tools reduced focus on the patient, and then represented a risk to patient safety.

**Conclusion** OR nurses and NAs perceive that digitalization on one side may facilitate work processes and information flow. However, on the other side digitalization may steel focus on the patient. These aspects should be taken into consideration in quality improvement initiatives and when introducing new digital tools.

**Keywords** Digitalization, Nurse anesthetist, Operating theatre, Operating room nurse

## Background

The advancement and innovation in medical technology is rapidly evolving, resulting in frequent implementation of new equipment [1]. Operating theatres are complex environments where technological equipment and information technology are used under the conduction of surgical procedures [2, 3]. The operating theatres have been introduced to digital innovations through centuries, and the last 20 years this has included for example cognitive aids, electronic healthcare records, big data, artificial intelligence and wireless wearable patient monitors [4].

Research suggests that 50% of adverse events due to anesthesia and surgery are preventable, nevertheless this

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is a significant cause of mortality and morbidity internationally [5]. In a review from 2023, Webster et al. [4] claim that even though the technological development has led to a significant reduction in anesthesia-related mortality, it has also led to a shift in the approach to patient safety. This shift includes moving from a person-centred approach where clinicians solely were responsible for patient safety, to a more complex and variable socio-technological approach where individuals need to perform safely and effectively, alongside using technology, to ensure patient safety in the operating theatre.

The American Association of Colleges of Nursing underlines that core competencies for nursing education include informatics, social media, and emergent technologies and their impact on decision making and quality [6]. Also, the Organisation for Economic Co-operation and Development (OECD) states that digital transformation in the health sector requires adaptive change in human attitudes and skills, as well as of legal frameworks and the organization of work [7]. To facilitate digitalization in healthcare, providing healthcare professionals with new digital technology is not sufficient [8]. The literature shows that healthcare personnels' knowledge is a crucial determinant of whether digital technology is adopted or not [9, 10]. Moreover, healthcare workers' attitudes are important aspects in the acceptance and implementation of new technologies [11, 12]. Studies have shown that barriers for nurses using digital technology are lack of digital experience, confidence, competency and education [13, 14].

In Norway, the operating team most commonly consists of surgeons, anesthetists, operating room (OR) nurses and nurse anesthetists (NAs). To work as an OR nurse or a NA, the education consists of either a 90 European Credit Transfer and Accumulation System (ECTS) further education program, or a 120 ECTS master's degree program. OR nurses and NAs are most commonly present throughout the perioperative pathway, while

anesthetists may be responsible for several patients at the same time, and surgeons are present mainly during surgery [15, 16]. This distribution of tasks has also been described internationally [17–19].

Some studies have explored anesthesia personnels' perspectives on anesthesia information management systems [20, 21]. Beyond this, no studies exploring digitalization in general in the operating theatre, from specialized nurses' perspectives, have been identified. Hence, the aim of the current study was to explore OR nurses' and NAs' experiences with digitalization in the operating theatre.

## Materials and methods

Qualitative studies are appropriate for in-depth exploration of people's experiences and perspectives [22]. As such, a qualitative design was chosen, using individual interviews with OR nurses and NAs in the period November–December 2022. The authors (all female) comprised an OR nurse, a NA (PhD, Professor), an emergency nurse (MSc) and two intensive care nurses (MSc, one with a PhD, experienced with interviews and qualitative analysis). The study adheres to the Consolidated Criteria for Reporting Qualitative Research (COREQ) [23].

## Setting and participants

The study was conducted in a hospital in Southeastern Norway, with a catchment area of approximately 320 000 inhabitants. The hospital has nine operating theatres, offering both acute and elective surgery. Most commonly, the surgical team consists of two OR nurses, one NA, and two surgeons. The anesthetists are most commonly responsible for more than one patient, and hence are not present throughout patient pathway.

A purposive sampling strategy was used to identify participants that could provide in-depth information about digitalization in the operating theatre [24]. Managers from the operating theatre were asked to recruit OR nurses and NAs with a variation in gender, age and years of clinical experience. Inclusion criteria were a minimum of 50 per cent clinical work and having worked in the operating theatre during the past year. After having accepted to participate, the first and last author respectively contacted the OR nurses and NAs to agree on time and place for an interview.

## Data collection

An interview guide was developed based on current research on anesthesia information management systems [20, 25–28], and several discussions between all of the authors (see Table 1).

The guide was piloted in one experienced OR nurse and NA respectively. The pilot led to minor changes in

**Table 1** Interview guide

**1. Which equipment or tools do you associate with "digital" in your work?**

2. Have these tools changed your work pattern or how you work?
3. What are the advantages of such digital tools?
4. What are the disadvantages of such digital tools?
5. Have you received sufficient training and/or education to be able to use the tools?
6. Do you have any thoughts on how the use of digital tools may impact communication with patients?
7. Do you have any thoughts on how the use of digital tools may impact communication with relatives?
8. Do you have any thoughts on how the use of digital tools could have made your work more effective?
9. Is there anything else you would like to add regarding the use of digital tools in your work?

the interview guide, and the questions were deemed relevant and understandable.

The last author conducted interviews with OR nurses in a meeting room separated from the operating theatre. The first author conducted interviews with NAs digitally on a secure platform (Teams<sup>R</sup>) with both sound and video. This method has been widely used and is assumed a viable alternative to face-to-face interaction [29]. The audio of the interviews was digitally recorded and transcribed verbatim by an external transcriber, who had signed a non-disclosure agreement. Due to pragmatic reasons, the aim was to include eight OR nurses and eight NAs respectively. However, after these interviews, saturation was assumed reached, meaning that no new themes were identified in consecutive interviews [30].

### Analysis

A reflexive, thematic analysis in-line with recommendations from Braun & Clarke [31] was used to analyze the data. In the reflexive approach, Braun & Clarke suggest using multiple coders to “sense-check ideas, or to explore multiple interpretations” of the data. As such, in step 1 of the analysis, all the authors read the transcripts to familiarize with the data. Then, in step 2, the first and last author individually and inductively coded the interviews line-by-line, as a representation of their interpretations of patterns of meaning across the dataset. This was done in a Word document, with the transcripts in the left column, the codes in the middle column, and potential comments and/or conflicts in the right column. The codes were then shared and discussed with the remaining authors, leading to a “flexible and organic coding process”, as underlined by Braun & Clarke. In step 3, the codes were reviewed by the first and last author individually,

searching for patterns and preliminary themes across the codes. Braun & Clarke describe this as “organizing codes around a relative core commonality” [31], and was based on the first and last authors’ own interpretations. Then the two authors discussed their interpretations. In step 4, the preliminary themes were reviewed and discussed by all of the authors, focusing on what should be included and excluded from each theme, and whether the themes were coherent and rich enough to represent a theme. The first and last author then reviewed the data, codes and preliminary themes. Results of this recursive and iterative process were then presented to the rest of the authors, leading to step 5- defining and naming the themes. Table 2 presents an example of the analytic steps.

### Ethics

The study was conducted in line with the ethical guidelines for research in the Declaration of Helsinki [32]. All participants provided willing, informed, written consent to participate. The study was approved by the Norwegian Agency for Shared Services in Education and Research (Sikt, project no. 538537). According to Norwegian legislation, no ethical approval was needed. The study was approved by the management at the hospital.

### Results

In total, eight OR nurses (all female) and eight NAs (two male) were interviewed. The interviews lasted from 20 to 40 min (median 27). The participants’ age ranged from 27 to 58 years (median 40.5 years), and their experience as an OR nurse/NA ranged from 1 to 20 years (median 4.3 years). The participants’ background information is not combined due to confidentiality issues.

**Table 2** Example of the analysis process

Transcript	Codes	Preliminary themes	Theme
It's primarily Metavision <sup>®</sup> I think about, that requires most time of the digital tools in my daily work...It (Metavision <sup>®</sup> ) was supposed to make things easier, but in many ways it doesn't feel easier...because we were meant to be two during induction and emergence of anesthesia...But often, I am alone at emergence, and at the same time I am supposed to document in Metavision <sup>®</sup> (NA 3)	Metavision <sup>®</sup> Requires time most time Supposed to make things easier Doesn't feel easier Meant to be two during induction and emergence of anesthesia Alone Supposed to document at the same time	Time requiring Reality does not match intentions Parallel tasks	Changing the work process
Focus on the (surgical) field. And that you've become unavailable to those working together. You are somewhat hidden behind the computer (OR nurse 5)	Focus interrupted Become unavailable Working together Hidden behind the computer	Patient safety depends on focus in the field Teamwork is essential Need to be available	Implications for patient safety

Metavision<sup>®</sup> is a digital information management system implemented in the current operating theatre. OR nurse = Operating room nurse. NA = Nurse anesthetist.

Representative quotes are marked as OR-number and NA-number as appropriate

The participants included several different tools in their description of 'digital tools' in the operating theatre: a surgery planning system (Imatis®), a drug administration system (DELTAR®), a blood gas device, a system for resource planning (GAT®), a system for storing and sharing pictures (PACS®), the medical journal system (DIPS®), mobile cellphones with various applications (apps), and the digital information management system (Metavision®). There were no differences in tools described between OR nurses and NAs. However, the main emphasis in the OR nurses was the impact of the mobile cellphones, while the main emphasis in the NAs was the impact of Metavision®.

Through analysis two themes were identified, namely (1) Impacting the work processes, and (2) Implications for patient safety.

### Impacting the work processes

Most of the participants stated that digital tools in many cases facilitated a smoother work process, for example through that pictures (through PACS®), laboratory results (through DIPS®), or ordering blood products (through app) were easily accessible both day and night. However, seemingly, the older and more experienced participants were more critical to such tools, due to issues with the software, problems with logging on to programs and knowing where to access various information. This again was experienced to delay the work processes. One of the OR nurses stated:

"One of the disadvantages with Metavision is that when I have documented, it's hard to find it again. Many steps to get both here and there, checking what I actually wrote...I find this hard" (OR-6).

Also, one of the NAs prompted:

"I have much less time to do other things, that I would like to do. We were not more people when Metavision was introduced. It was supposed to get easier, but I don't think it is" (NA-3).

All of the OR nurses pointed out the mobile cellphones as disturbing elements that impacted on their work processes. Several of the participants prompted that the cellphones made them "always available". This was both seen as an advantage, because they also could contact surgeons more easily, and as a disadvantage. For example, one of the OR nurses expressed feeling like a 'secretary' for the surgeons, due to the cellphones. She said:

"If there is 3–4 surgeons in the field...Their phones keep ringing. It disturbs me in my work. I have to bring them the phone, or on speaker, and it keeps me from doing what I was supposed to" (OR-4).

This disadvantage and element of disturbance was supported by all the OR nurses. However, the NAs mainly emphasized positive effects of introducing cellphones in the operating theatre. This was related to the apps and

the possibility to order blood products or transport for the patient, and to the availability of looking up procedures or doses for medications. Also, the use of role-specific cellphones was seen an advantage, making it easy to get in touch with available personnel to support in the induction or emergence of anesthesia.

To NAs, Metavision® made the greatest impact on their work processes, due to the system automatically collecting clinical information that previously were documented manually on paper. This required parallel actions at induction and emergence of anesthesia, both plotting information that was not automatically collected and taking care of the patient. Also, the system allowed for anesthesiologists to supervise the anesthesia from a distance, leading to that some of them were less present in the operating theatre. One of the NAs prompted:

"Even if they (the anesthetists) are not present in the operating theatre, they know what's going on. Its communicated, even if its not formal. I don't know, but they are quite updated when entering the operating theatre" (NA-8).

Another NA also stated that taking care of both the patient and the system was stressing:

"Many things are ongoing at induction, and it doesn't always flow by itself...And I keep thinking that it's important to register right times, induction start, surgery start, tube insertion and so on..." (NA-6).

The OR nurses also underlined the parallelity of other tasks and plotting in Metavision®. One of them described:

"We are dependent on Metavision, daily, in relation to what we use to disinfect, skin status, local anesthesia, positioning, duration of surgery...And it's important to register in real-time, in relation to the colleague replacing your shift... To ensure the continuity..." (OR-2).

Hence, having to use the digital tools at the same time as any other tasks in the patient's perioperative pathway was reported by all respondents as impacting on their work processes as compared to before these tools were implemented.

### Implications for patient safety

Both the OR nurses and the NAs perceived that digital tools were both facilitators and barriers to ensure patient safety. This also depended on aspects such as functionality, network capacity, and user competence. When functioning as intended, the digital tools were described to "make information more accessible", "avoid misunderstandings due to bad handwriting", "make it easier to get in touch with other personnel", or "ensuring registration in real-time", indicating increased patient safety. However, all of the participants reported situations where for example Metavision® did not work appropriately, and that this in worst case could negatively impact on patient safety. OR-8 stated:

One gets vulnerable...It has happened that the network is down. That's a weakness, and you never know. Then, we have to search for other solutions (than Metavision®).

Also, NA-5 emphasized this "weakness in the system", prompting:

If the tools (digital) don't work, as they often don't, there are errors in the registrations...And then, you get really tied up to that, and can't get further with the process...And, it's stressing as well....

To the OR nurses, the mobile cellphones were seen as a threat to patient safety due to taking up both their own and the surgeons' attention during surgery. One of them said:

"The phone rings all the time. And there you are with the patient. And then, you must turn away from the patient, cancel what you're actually doing...And it's a stress factor both to me, the patient, and the whole surgical team" (OR-6).

This was underlined by all of the OR nurses. Also, NA-5 had observed similar disturbance due to cellphone use in the operating theatre.

The NAs were more focused on Metavision®, as the digital tool they used the most. Here, it seemed like the younger NAs saw this as a natural part of their handling of the patient, having automatized the plotting and not using much energy to use it. At the same time, several of the NAs reported a negative impact of Metavision® on their awareness on the patient, and hence patient safety. Especially during induction of anesthesia, the tool required lots of "plotting", in parallel to actions needed to be taken to the patient. One of the NAs said:

"Often there are problems, errors in the registration, and you use a lot of time, and then decrease your time with the patient" (NA-5).

One of the NAs reported a worry that new students got a "wrong" approach to using Metavision® in combination with airway-handling or drug administration:

"If the documentation steals focus, the students will not learn the clinical assessment" (NA-3).

Also, some of the OR nurses stated that the focus on Metavision® instead of the "old" paper documentation system had led to less focus on the patient. One of them said:

"It may happen that we are not so available physically... When the attention should be in the field, and the eyes are on the screen..." (OR-2).

## Discussion

The results indicate that digital tools impact both OR nurses' and NAs' work processes positively through making these more comprehensive, but also negatively making the work processes vulnerable for disruptions, and leading to a need for parallel actions. Also, based on OR

nurses' and NAs' experiences, digitalization seem to have both positive and negative implications for patient safety.

Even if OR nurses and NAs mainly exemplified the impact of digitalization with either mobile cell phones or Metavision® respectively, they all expressed that digitalization impacted their work processes in one or another way. Positively, digital tools were reported to make the work processes more comprehensive. This is supported by a 2022 systematic review [33] focusing on digital health competencies among healthcare professionals. In this review, results showed that healthcare personnel perceive that digital tools are useful for smoothing the care processes, and for improving its quality and patient satisfaction. According to the World Health Organization (WHO) [1], digital transformation of healthcare is expected to enhance outcomes and create more evidence-based knowledge, skills, and competencies for professionals to support healthcare delivery [1]. Worldwide, operating theatres are under pressure due to an increasing need for surgery overriding the capacity [34]. In the US, surgery represents nearly 50% of hospital expenditures and 30% of overall healthcare costs [35, 36]. In the UK, the average hospital uses 73% of planned theatre hours, equating to a potential loss of up to 280,000 elective operations annually [37]. This underlines the importance on focusing on digitalization that support smooth work processes.

In contrast, the OR nurses and NAs in the current study also stated that digitalization negatively impacted on their work processes, through both being disruptive and leading to a need for both handling the digital tool and the clinical task. This is in-line with studies showing that implementation of new technology in operating theatres disrupt activities and workflow [2, 20, 38]. For example, a recent study on anesthesia personnel's perspectives on using Metavision® [21] indicated that this impacted on the collaboration between NAs and anesthesiologists, leading to that NAs were more occupied with the system than with the patient. According to the Expert Panel on Effective Ways of Investing in Health (EXPH), digital health can provide additional work processes next to existing ones, or completely replace current processes [39]. In our study, it may seem that OR nurses and NAs mostly experienced that the digital tools added to the work processes, rather than representing a replacement of previous tasks. A 2018 systematic review [2] aiming to identify success factors for effective implementations of new technologies and technological equipment in operating theatres, found that implementation of new medical equipment runs along all different sorts of pathways before being accepted in clinical surgical practice. The review underlined several essential factors facilitating digitalization, such as: (1) communication with relevant stakeholders to prevent errors, (2) updated protocols and



checklists, (3) management strategies for implementation, and establishment of multidisciplinary teams, and (4) involvement of staff in training, setting up, using, and disassembling medical equipment.

Both OR nurses and NAs in the current study experienced that digitalization increased patient safety through making information more accessible and understandable, enabling proper documentation and making it easier to get in contact with other personnel when needed. Previous studies have also underlined a positive impact of digitalization on information and documentation [27, 28, 40]. However, according to the WHO, there are multiple and interrelated factors that can lead to patient harm [41]. Of these, issues related to health information systems, such as problems with electronic health records or medication administration systems are reported. For example, in patients that are unconscious or cognitively impaired, essential information included in the Surgical Safety Checklist [42] may only be available through the digital systems.

In this study, OR nurses and NAs also reported that digitalization had negative implications for patient safety, due to stealing focus from the patient and the clinical tasks. This issue has also been underlined in previous studies [21]. Specifically, the use of smartphones in the operating theatre has been reported as disturbing, and a potential threat to patient safety [43, 44]. Even if none of the participants in the current study reported of concrete situations where the digital tools had led to adverse events, the feeling of lacking overview and control may impact on their attitudes to digitalization. In a future where digitalization certainly will develop further, these are issues that should be confronted during OR nurse and NA education. This is especially important, since healthcare personnel's attitudes are shown to impact on whether innovations are adopted or not [7, 10, 12].

In this study, it seemed like older and more experienced OR nurses and NAs were more sceptic to digitalization. To our knowledge, no studies have explored the association between age and/or experience and attitudes to digitalization in the operating theatre. However, Warshawski et al. [45] found that nursing students self-efficacy using digital technology was significantly higher than that of nurses. Digital literacy has been defined as 'the ability to access, manage, understand, integrate, communicate, evaluate and create information safely and appropriately through digital technologies for employment, decent jobs and entrepreneurship' [46]. A 2020 study [47] on digital literacy levels in healthcare personnel found that younger staff ( $\leq 50$  years) were identified to be more frequent users of computers, mobile devices, email, the Internet and social media when compared with older staff ( $> 50$  years). However, a 2022 literature review [48] on digital literacy among students in general, found that even

though there was an association between age and digital literacy, this was not the only determinant, and hence not that important to be taken into consideration in the process of making educational policies.

### Methodological considerations

Within the qualitative research design lies the limitation of generalizability of findings. Also, the study was conducted in one hospital and in a Norwegian setting, and findings may not be transferable to other settings.

The data collection and analysis have been thoroughly described, and the analysis includes the perspectives and reflections of both an OR nurse (last author), a NA (first author), an emergency nurse and two intensive care nurses. This may increase the credibility and trustworthiness of the study. Rigour was ensured through a systematic approach throughout the planning and conduction of the study, as well as through repeated discussions between the authors. Some researchers claim that the validity of a study may be improved through letting participants read through and give feed-back on the transcripts and analysis of findings [49]. However, this was not done.

The participants were familiar to the interviewers, as colleagues in the operating theatre. This may represent a bias. However, the issues presented are not sensitive or confidential, and the authors perceived that the participants openly shared their experiences, perspectives and reflections.

Also, it may be argued that a mobile cellphone is not a "digital tool". However, the participants perceived this as a digital tool. Hence, we have included their experiences regarding these as well.

### Conclusion

Results show that participants experienced mobile cellphones as part of digitalization in the operating theatre. Positively, digital tools were assumed to make work processes more comprehensive. Negatively, digital tools were assumed to disrupt the work process and the focus on the patient, and hereby affect patient safety. These aspects should be taken into consideration in quality improvement initiatives and when introducing new digital tools. Educational institutions and clinics should focus on increasing students' and nurses' digital literacy, to ensure proper adoption of digital tools in the operating theatre in the future.

### Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12912-024-02574-9>.

Supplementary Material 1

## Acknowledgements

We thank the participants for their contribution to this study.

## Author contributions

ACLL, VN, RS, AKHT and EO have all made substantial contributions to conception and design of the study, acquisition of data, analysis and interpretation of data. ACLL and EO performed the interviews. ACLL wrote the initial draft of the manuscript, and VN were involved in revising it critically for important intellectual content. All authors have given final approval of the version to be published, and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

## Funding

The study was funded by collaborational fundings from Østfold Hospital Trust and Østfold University College. The funding bodies did not take part in planning, conduction or writing up the study.

## Data availability

The datasets used and/or analyzed are available from the corresponding author upon reasonable request.

## Declarations

### Ethics approval and consent to participate

The study was based on guidelines for ethical research as stated in the Declaration of Helsinki [32]. A willing, informed, written consent to participate was obtained from all participants. All methods were carried out in accordance with relevant guidelines and regulations: In Norway, the Regional Committees for Medical and Health Research Ethics (REC) are responsible for approving medical and health services research projects. When patient data is not involved in the project, the study do not need approval from REC [50]. The study was approved by the Norwegian Agency for Shared Services in Education and Research (Sikt, project no. 538537).

### Consent for publication

Not applicable.

### Competing interests

The authors declare no competing interests.

Received: 4 December 2023 / Accepted: 4 December 2024

Published online: 18 December 2024

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