Journal of PeriAnesthesia Nursing xxx (xxxx) xxx

Contents lists available at ScienceDirect

Journal of PeriAnesthesia Nursing

journal homepage: www.jopan.org

Research

Smart Glasses for Anesthesia Care: Initial Focus Group Interviews with Specialized Health Care Professionals

Per Enlöf, MSc, RNA [a, b, *], Charlotte Romare, MSc, CCRN [c, d], Pether Jildenstål, PhD, CRNA [a, b], Mona Ringdal, PhD, CCRN [a], Lisa Skär, PhD, RN [c]

[a] Sahlgrenska Academy, Institute of Health and Care Sciences, University of Gothenburg, Gothenburg, Sweden
[b] Department of Anesthesiology, Surgery and Intensive Care, Sahlgrenska University Hospital, Gothenburg, Sweden
[c] Department of Health, Blekinge Institute of Technology, Karlskrona, Sweden
[d] Region Blekinge, Intensive Care Unit, Karlskrona, Sweden

Keywords:
anesthesia
smart glasses
physiological monitoring
patient safety
qualitative research

A B S T R A C T

Purpose: Smart glasses are a kind of wearable technology that gives users sustained, hands-free access to data and can transmit and receive information wirelessly. Earlier studies have suggested that smart glasses have the potential to improve patient safety in anesthesia care. Research regarding health care professionals' views of the potential use of smart glasses in anesthesia care is limited. The purpose of this study was to describe anesthesia health care professionals' views of smart glasses before clinical use.
Design: A qualitative descriptive study.
Methods: Data were collected from focus group interviews and analyzed using thematic content analysis.
Findings: Three categories of participants' views of smart glasses were created during the analysis: views of integrating smart glasses in clinical setting; views of customized functionality of smart glasses; and views of being a user of smart glasses. One theme, striving for situational control, was identified in the analysis.
Conclusions: Smart glasses were seen as a tool that can impact and improve access to patient-related information, and aid health care professionals in their struggle to gain situational control during anesthesia care. These are factors related to increased patient safety.

Anesthesia care has focused on improving patient safety over the past few decades.[1] A growing number of patients with complex conditions are anesthetized today. This requires extensive monitoring of patients' vital signs (VS) such as blood pressure, oxygen saturation, heart function, respiratory rate, and cerebral function. These parameters are key aspects of detecting life-threatening events early and enhancing patient safety during anesthesia.[2,3] Today, stationary multiparameter monitors have been developed that display real-time VS and provide access to clinical hospital systems offering a comprehensive range of patient information and powerful analysis tools at the point of care.[3]

Working in anesthesia means using various personal skills. Every day health care professionals in anesthesia work closely together to optimize patient care in teams that include different professions. Good teamwork is based on appropriate communication.[4] Anesthesia care has a long history of enhancing patient safety: teamwork, use of protocols and checklists, and improved monitoring of patients' VS have all contributed to safer care for patients undergoing anesthesia. However, patients still suffer complications, related to communication and monitoring of VS during anesthesia care. Improved technology that can facilitate the health care professionals' work in anesthesia care is therefore still needed.[1,5-9] One technological innovation that has proved useful in the operating room (OR) setting is smart glasses[10] (Figure 1).

The purpose with smart glasses is to create convenient, hands-free access to various kinds of information.[11] The product is a kind of wearable technology that gives users sustained, hands-free access to data and can transmit and receive information wirelessly. This information can be communicated to other smart glass users, and glasses from some brands can capture images, record videos,

Conflict of interest: None to report.
Funding: This research was funded by Sahlgrenska University Hospital (Department of Anesthesia and Intensive Care), Gothenburg, and the Scientific Council at Region Blekinge in Southern Sweden. The funders have not influenced any part of the study.
* Address correspondence to Per Enlöf, Institute of Health and Care Sciences, University of Gothenburg, Gothenburg, Sweden.
E-mail address: per.enlof@vgregion.se (P. Enlöf).

https://doi.org/10.1016/j.jopan.2020.06.019

Please cite this article as: Enlöf P et al., Smart Glasses for Anesthesia Care: Initial Focus Group Interviews with Specialized Health Care Professionals, Journal of PeriAnesthesia Nursing, https://doi.org/10.1016/j.jopan.2020.06.019

Figure 1. Smart glasses from Google (Google Glass Enterprise). This figure is available in color online at www.jopan.org.

and serve as telephones. Smart glasses can be operated by voice or physical input.[12]

Although there are several commercial Web sites describing the use of smart glasses in a surgical environment, the number of scientific studies is limited. Examples of studies that have been published describe the use of smart glasses in neurosurgical navigation and to complete surgical safety checklists.[13,14] A systematic review of wearable technology, including smart glasses, in the OR concludes that in several intraoperative specialties wearable technology has potential to improve safety, communication, and education.[10] A recently published scoping review highlights both benefits and limitations related to health care professionals' use of smart glasses in situations occurring in anesthesia care.[15] Evaluation of a head-mounted display that visualizes VS for anesthesiologists during general anesthesia prompted the conclusion that more research is needed to determine what kinds of information should be displayed and whether a head-mounted display can improve the anesthesiologists' performance.[16]

Like smartphones or tablets, smart glasses work through applications. The application needs to be tailored to the specific setting.[17] In an earlier study, health care professionals' views of smart glasses in an intensive care setting were explored.[18] Anesthesiology and intensive care have many similarities, such as that sudden, fast, and serious changes may occur in the patient's condition. VS are shown to be important in both settings to provide safe and high-quality care.[19,20] However, there are essential differences in each setting, for example, patient population, duties, tasks, environment, and responsibilities. Because smart glasses have been suggested to improve patient safety in anesthesia,[16,21] this product might be a part of future anesthesia care. There is a lack of research in the area of anesthesia health care professionals' views of the smart glass technology. Their views are important information for developers creating a customized application for anesthesia care. With this study, we want to explore anesthesia health care professionals' views of the potential use of smart glasses in an anesthesia setting. Clinical use of smart glasses is not part of this study.

Purpose

The aim of this study was to describe anesthesia health care professionals' views of smart glasses before clinical use.

Methods

To achieve the aim, a qualitative design was used. Data were collected using focus group interviews. Focus group interviews have proved advantageous in studies of how people perceive a phenomenon,[22] in this case smart glasses. Collected data were analyzed using thematic content analysis.[23]

Setting

This study was conducted in an OR at a university hospital in Sweden where patients undergo neurosurgical, hand, ear, nose and throat, and plastic surgery. Surgeries last from 30 minutes to 20 hours. The workforce consists of approximately 80 health care professionals, comprising scrub nurses and scrub nurse assistants, nurse anesthetists (NAs) and anesthesia assistants, anesthesiologists, and surgeons with the aforementioned specialties. A minimum of six health care professionals, including NAs, anesthesia assistants, anesthesiologists, scrub nurses, scrub nurse assistants, and a surgeon, constitute the surgical team surrounding the patient. Besides working in the OR, NAs, anesthesia assistants, and anesthesiologists also provide anesthesia for patients undergoing magnetic resonance imaging, interventional surgery, and computed tomography. They all belong to the trauma team, which carries out the primary survey of trauma patients in the emergency department and monitor critically ill patients during intrahospital transports.

Participants

All 30 health care professionals working as NAs or anesthesiologists were invited to participate. The NAs were all nurses specialized in anesthesiology, and the physicians were anesthesiologists or anesthesiologists in training. Anesthesia assistants were not invited to participate because they do not monitor VS in their profession. The management of the OR was contacted to get permission to carry out the focus group interviews at the unit and to ask health care professionals to participate. Information about the study was given both verbally, from the first author, in the daily staff meetings and on strategically placed posters. Written consent was obtained before the focus group interviews started. In total, 16 health care professionals in four focus groups took part (Table 1). Focus group interviews were conducted with anesthesiologists and NAs in separate groups.

Ethical Approval

Ethical approval was obtained from the Regional Ethical Review Board in Lund, Sweden (Dnr 2016/773 and Dnr 2018/107). All the participants were informed that the study was conducted on a voluntary basis and they could withdraw their consent at any time. This study was conducted according to the principles of the Declaration of Helsinki.[24]

Data Collection

Data were collected in March 2018. All the focus group interviews were conducted similarly and started with a short presentation of the research project. Smart glasses from Google (Google Glass Enterprise) were available for the participants to try on during all four focus group interviews to increase understanding and contribute to discussions. Some of the participants had seen and read about smart glasses, but no one had used them before.

An interview guide[22] with the following questions was used:

- "Tell me when you think smart glasses might facilitate your work?"

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Table 1
Participants' Characteristics

	Anesthesiologists (n = 4)	Nurse Anesthetists (n = 12)
Focus groups	1	3
Age (y)	38*, 29-48	42*, 33-57
Female gender	2	7
Anesthesia experience (y)	7*, 1.5-12	12*, 1-32

* Data on participants' characteristics, with figures representing the number (n) or median.

- "Tell me what kind of information you would like to see in the smart glasses?"
- "Tell me how you would like the information to be presented to you?"
- "Tell me if you think smart glasses can affect patient safety and, if so, how?"

Questions like "Can you tell me more?" were asked, to follow up some of the answers given by the participants. Because the second author had more experience in conducting focus group interviews and had no previous relationship with the participants, she was selected as the moderator, with the first author sitting in as an observer. The moderator's role was to guide the discussions and ask follow-up questions, whereas the observer took notes, observed nonverbal body language, and asked follow-up questions. The focus group interviews took place in a conference room just outside the OR and lasted between 23 and 43 minutes. They were recorded digitally and transcribed verbatim by the first author. After the last focus group interview, the first and second authors agreed that only a few new issues had come up, whereas the majority had been brought up in earlier interviews. This indicates some data saturation.[22]

Data Analysis

Data were analyzed using thematic content analysis as described by Granheim and Lundman.[23] The transcribed text was read through several times to get a sense of the whole. Meaning units (sentences or paragraphs) related to the aim of the study were marked. Long meaning units were condensed, with the core preserved, and meaning units were then labeled with codes. To reach consensus between the first and the second author, meaning units were marked, condensed, and coded together in the first focus group interview. For the other three, this work was conducted by the two first authors separately and then compared and discussed to achieve a joint result. The codes were arranged in subcategories, which were then arranged into categories. This process was conducted by the first and second author together, continuously moving back and forth between the whole and parts of the text. The analysis was also discussed with the third and fifth authors, and finally the whole research team reviewed the final article together.

Findings

Three categories and 11 subcategories were created during the content analysis (Table 2). They are presented below, with categories as section headings and subcategories in italics. During the analysis, health care professionals' ambition to gain control in anesthesia care situations to provide patient safety became evident. During anesthesia care, they seemed to be constantly striving for a feeling of control of the situation. Hence, *Striving for situational control* represents the latent content, the theme, throughout all the categories.

Views of Integrating Smart Glasses in a Clinical Setting

In the subcategory *using smart glasses for monitoring VS*, participants believed that smart glasses could be used to increase the feeling of control when users gain access to VS all the time, regardless of what kind of tasks they carry out. They felt that when health care professionals use smart glasses for monitoring VS, they might possibly see changes in VS faster than by using the stationary monitor.

> *FG3: That you can keep better track of your patient, as simple as that … Yes, hemodynamically, and oxygen saturation … that you can … keep track all the time.*

Another topic regarding monitoring VS was the option of using smart glasses to mute alarms. The participants believed this was positive, especially when they were not working close to the stationary monitor and therefore unable to mute the alarm. This was seen as positive for patient safety and the environment in the OR. Participants thought the environment would be less noisy if they could mute alarms without having to confirm it on the stationary monitor.

> *FG1: As I said … environmentally … I think there'd be fewer alarms in the OR, if you could turn it off a bit faster. So … that's also positive for patient safety.*

The analysis showed how participants wanted to *use smart glasses in caring situations*. Examples given were when health care professionals move around in large ORs, in emergency situations, and during intrahospital transports.

> *FG4: I think during almost all transportation, even when we've been in the OR and are on our way to the intensive care unit or neurosurgical intensive care unit.*

> *And sometimes we walk ahead of the bed and can't see the monitor [used today] at all.*

The analysis also reveals how smart glasses could be used in teaching situations. Both NAs and anesthesiologists believed that smart glasses could enable supervisors to take a step back and let the students be more independent, whereas still maintaining control in the situation by using smart glasses.

> *FG4: I mean when teaching students, for instance, if they're learning how to intubate and wearing smart glasses, you don't have to look over their shoulder. Instead, you could watch a monitor using smart glasses, see what they're seeing and give them advice.*

Other examples given were in a situation when health care professionals are unable to see the stationary monitor. For example, when they move between different rooms while monitoring patients during computed tomography or turn their backs on the stationary monitor in the OR, and during induction and intubation. Regarding intubation, all NAs agreed that smart glasses could be useful in this situation. Anesthesiologists also talked about the

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Table 2
Overview of the Findings

Subcategories	Categories	Theme
To use smart glasses for monitoring vital signs To use smart glasses in caring situations To use smart glasses for communication and documentation To use smart glasses as support in decision-making	Views of integrating smart glasses in a clinical setting	Striving for situational control
Vital signs required to facilitate monitoring To provide information from electronic health records Requests regarding visual layout in smart glasses Technical requirements for smart glasses To control smart glasses	Views of customized functionality of smart glasses	
To be affected by smart glasses To wear smart glasses	Views of being a user of smart glasses	

The subcategories, categories, and theme created during thematic content analysis.

situation of monitoring patients during insertion of a central venous catheter and in the recovery room. Participants felt that patient monitoring can be difficult to perform in these situations today.

Using smart glasses for communication and documentation was seen as positive by the participants. They concluded that smart glasses could contribute to improve both aspects, especially in emergency situations. Being able to talk hands free to other smart glass users, and thereby avoiding telephones, would leave both their hands free to do other things. But there was also some concern that a product like this might cause confusion. Participants thought that other health care professionals might get confused if a smart glass user was talking to the glasses but bystanders thought the user was talking to them.

FG2: But in that case it would be a good thing if it could replace the telephone … So I could use this [smart glasses] to make phone calls.

Then you could continue working with your hands even during telephone calls.

They also talked about the possibility of sharing and receiving information via smart glasses. NAs felt a positive and calming feeling knowing that the anesthesiologists in charge could access the same visual information as themselves, without being in the same physical place.

FG3: Yes, then it's good … communication with the anesthesiologist as well, I think … that you like … that they can see in real time what's going on.

Anesthesiologists were positive about being able to receive notifications via smart glasses. If VS are abnormal, they want to get a notification and then have the abnormal information displayed in front of them. NAs saw smart glasses as a tool to enhance documentation. The ability to take a photograph or record a video to depict something abnormal was seen as positive. They thought that this could enhance patient safety.

Participants raised the question of how *to use smart glasses as a support in decision-making*. Anesthesiologists expressed the wish to use smart glasses to supplement their decision-making but stated that smart glasses could never replace a face-to-face meeting with a patient.

FG2: There are so many different parameters to consider now. So the monitor itself gives you an idea, but the nurse might as well tell you. Often you need a physical exam as well.

On the other hand, NAs mentioned the opportunity to access different documents via smart glasses. Checklists, treatment guidelines, and other routine documents were among the proposals to help them in their decision-making.

FG1: In case something happens, let's say you get an alarm from the monitor for asystole, then glasses could be a tool for visualizing the treatment guidelines or… a checklist of what needs to be done.

In addition, NAs wanted a function to activate reminders and a timer function, both of which were seen as positive features for patient safety. NAs were concerned about technical issues. They feared that smart glasses would not visualize the correct information, causing them to make decisions on false grounds, and that this would be negative for patient safety.

FG4: If there's a delay in smart glasses [regarding visualization of VS] then it can affect patient safety negative if you trust the smart glasses instead of observing the patient.

Views of Customized Functionality of Smart Glasses

The analysis clearly showed what kinds of *VS participants require to facilitate monitoring.* Most of the participants wanted to choose specific VS they thought were more important than others to visualize. The most common ones mentioned were blood pressure, blood oxygen saturation, and pulse or electrocardiogram. These VS were mentioned in all four focus group interviews. Other frequently mentioned VS were respiratory rate and end-tidal CO_2. Intracranial pressure was also mentioned. However, some NAs expressed that the best thing would be to have all VS available, visualized in smart glasses.

FG1: At least pulse rhythm, blood pressure, oxygen saturation, and respiratory rate.

But there were also NAs and anesthesiologists who did not want VS to be shown at all, as long as they were normal. They believed that VS, or a trend from VS should be visualized only when they are abnormal. Some preferred trends from VS rather than the actual number in general. As long as VS are correctly displayed, participants did not expect smart glasses to affect patient safety adversely. In addition to VS, participants also wanted *to provide information from electronic health records (EHRs)*. They believed that blood

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samples, blood type, and how much drugs the patient has received were important aspects.

FG2: So you could see that patient's EHR as well. I mean, you could get information from the nurse about what drugs have been administered and when, but if you checked it yourself it would be a lot easier.

Furthermore, the analysis showed participants' *requests regarding visual layout in smart glasses*. They agreed that layout in smart glasses should be as similar as possible to the current layout on the stationary monitors—with the same colors, character sizes, and disposition. If the information was displayed differently, participants thought it might confuse them.

FG3: Like you're used to. Otherwise it might mess things up.

Something obvious to both NAs and anesthesiologists was the fact that VS presented as numbers also require associated curves. They thought this would be important, because health care professionals need to be able to determine whether the numeric value is reliable. When an alarm occurs, participants wanted the number and associated curve only to be displayed, and once the alarm has been confirmed, for the layout to go back to normal again.

FG1: Curves are also good to show whether it's really an alarm. You often get an alarm, but you can see on the curve that it's really an interference. It's valuable to get a curve and not just a number.

Participants identified a risk in too much information being displayed in the smart glasses. They believed that this might make information intrusive, and that it might not be taken seriously, resulting detrimental to patient safety.

FG4: Because I think that too much information might make you choose not to look.

They believed that a problem like this could be solved if they were able to separate information in different menus. They could then switch between menus, preventing too much information from being displayed at the same time. When it came to reading a document on the smart glass screen, participants thought that this would most likely be difficult because the text would be too small. They believed that a guideline in the form of an A4 page, for example, might be easier to access using a computer.

Analysis revealed participants' views of *technical requirements for smart glasses* and, in particular, requests concerning smart glass battery life. The consensus was that the battery needs to last at least as long as one surgery. In this connection, participants also mentioned that smart glasses became very hot to wear after a while.

FG4: At least for several hours, they mustn't go flat. I mean, they need to last for the entire surgery.

Another requirement was that participants would prefer if they could have protective glass in smart glasses, to shield their eyes from splash. They also wanted them to be strong enough to withstand cleaning according to the current guidelines. Furthermore, participants had requests, and mostly doubts, regarding the wireless network provided at the hospital. The fact that smart glasses cannot function without this network made them question whether the network is reliable enough.

FG4: As long as the network's functioning, it may crash. Computer programs and so on can cause trouble.

Participants in all focus group interviews wanted to be able *to control smart glasses* with both touch and voice commands, especially the latter in stressful situations. They also wanted the ability to switch between menus using their fingers to swipe on the touch pad.

FG3: Maybe if there's an emergency situation, then you can use voice control instead.

When your hands are busy.
Yes, exactly.

Furthermore, participants raised questions about using voice commands when there are other health care professionals in the vicinity. They wondered how smart glasses could distinguish between the user's voice and the voices of others nearby. Would they perceive the commands when the surroundings are stressful and noisy? They also wanted to be able to use their native language for voice commands.

FG2: Yes, that depends on how well they function when the surroundings are noisy and there's a lot going on. It might be a very noisy environment. Would they [smart glasses] still listen to my commands?

Views of Being a User of Smart Glasses

The analysis revealed how participants think users might *be affected by smart glasses*. In general, most of them believed that smart glasses could provide advantages, but also feared they might be intrusive.

FG3: No, but it's going to be exciting [to try smart glasses in anesthesia care], because it might be like that you think that they' are so annoying.

Participants thought that smart glasses could give users a false sense of security. They might feel that everything is all right because they are wearing smart glasses, with constant access to information, and miss other important aspects of the patient's condition. Participants concluded that it might take some time to get used to working with smart glasses in the clinical setting. Concerns were also raised whether smart glasses might emit harmful radiation.

Among anesthesiologists, there was a concern that smart glasses would generate more alarms then the users can handle. In their opinion, a single anesthesiologist could potentially be attending to more than one patient at the same time, and if alarms from all the patients came to one person, the risk is that the situation might be unmanageable, especially if other machines in the vicinity are generating alarms as well. Anesthesiologists thought this would reduce patient safety.

FG2: It would be negative for patient safety if alarms started going off from another device at the same time, and alarms do go off from other devices while you're working with the patient.

Another issue that arose during the analysis is what it would be like *to wear smart glasses*. Participants found getting the screen in

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the right position complicated. Almost every participant needed a couple of minutes to place them correctly, in the right position for the whole screen to be visible. Moreover, participants expressed doubts about wearing smart glasses with their own prescription glasses. Several of the participants wore glasses on a daily basis, and while some found it possible to wear both pairs of glasses simultaneously, others did not. Suggestions included some way of attaching them to their own glasses or incorporating prescription glasses in the smart glasses. Participants had concerns about whether the glasses would stay in place properly when they leaned forward, for example. The participants found it advantageous that using this product means that they touch the stationary monitor less, and thought this might help to make the environment more hygienic. NAs and anesthesiologists also discussed how long they would want to wear smart glasses. The anesthesiologists were unwilling to wear them all day, whereas the NAs wanted to do so.

FG1: For me, if I were using them I'd want to wear them the whole day.

FG2: I don't think I'd want to wear them constantly, all day long.

Discussion

In this study, we describe health care professionals' views of future use of smart glasses in anesthesia care. The findings show that participants thought smart glasses may be helpful as a digital tool and might increase patient safety because of enhanced patient monitoring, improved documentation, and better teamwork. Concerns related to how smart glasses will affect users and about the risk of technical issues were raised. Before implementation, participants wished for similar layout as the monitoring equipment used today.

The analysis generated an underlying theme on how participants had a constant strive to gain a feeling of control in anesthesia care situations. They seemed to believe that smart glasses, among other things, could affect the feeling of situational control, mainly in a positive way. To experience a feeling of control in different situations has been stated to be important, especially in relation to stress. Experiencing a feeling of control in a given situation has the possibility to reduce stress.[25] This is corroborated with reference to anesthesia care by Verma et al,[26] who showed that lacking control in the work environment is anesthesiologists' main source of stress. Findings from this study indicate that smart glasses can have the ability to enhance the feeling of control in anesthesia care situations, and thereby possibly improve patient safety.

A similar previous study explored health care professionals' views of smart glasses in intensive care setting.[18] In line with our results, participants in that study also believed that smart glasses can enhance communication within the team, especially when team members are working in different locations. Both studies show, moreover, that participants believe it is important, especially in emergency situations, to avoid the risk of distraction and confusion by making smart glasses display configuration similar (in terms of views, layout, and colors) to what they are familiar with from existing monitoring equipment. This has been shown to be important in a study from a different environment. Motorists who become distracted divert their attention from the road and traffic, and as a result miss events and have longer reaction times.[27] Distractions within anesthesia care have been proven to possibly endanger patient safety.[28] A study by Merry et al[29] showed that when a new system of drug administration, including standardized coloring of drug labels, was implemented in anesthesia care, drug-related errors decreased.[29] This indicates that colors can help to structure visual input and may apply to the results from both the intensive care and the anesthesia care setting. For example, if a curve or number was presented in red, the health care professionals included in these studies instinctively knew that it represented arterial blood pressure. If another numerical value were presented in red, it might cause distraction and confusion, and possibly endanger patient safety. Accordingly, the layout for presenting VS in smart glasses must be customized to specific context and setting.

The study conducted in an intensive care setting[18] and our study show some differences among health care professionals. In intensive care, they focused more on the importance of interpersonal relationships between health care professionals and patients, and on how smart glasses might possibly affect these relationships. The importance of interpersonal relationships has been discussed before.[30-32] Participants in anesthesia care, on the other hand, had a stronger focus on their responsibility for monitoring VS, and on how smart glasses could help improve their access to VS, thereby enhancing their feeling of control in anesthesia care situations and possibly improving patient safety.[25,26]

The differences between the findings of the two studies may be explained by the participants' divergent task assignments and different forms of teamwork. Working in an intensive care unit means caring for the patient for a longer period than in anesthesia care provided in an OR. Intensive care may last from hours to months, whereas anesthesia care ranges from minutes to hours in duration. Intensive care entails a more holistic approach,[33,34] whereas anesthesia care is provided for a limited period and focuses on an advocacy approach,[35] making patient monitoring and VSs extra crucial for patient care. Studies have shown that NAs role in the team providing anesthesia care is often independent, making it both appreciated and experienced as lonely.[36,37]

Methodological Considerations

To describe participants' views of smart glasses, the authors chose to conduct a thematic content analysis on data collected through focus group interviews. Focus group interviews are known to be capable of yielding rich descriptions of phenomena when the participants are allowed to discuss matters among themselves.[22,38] In our opinion, the findings from this study provide a rich description of the phenomenon smart glasses in anesthesia care. Most of the employees available for interviews chose to attend. There was a wide range of years' experience among them and their gender distribution was even (Table 1). There were smart glasses available during the interviews, to enhance the experience and knowledge regarding the phenomenon. The two first authors conducted the focus group interviews in a conference room outside the OR, with limited risk of disruption. These factors may all enhance the credibility of this study.[22,39]

Each of the four focus groups in this study comprised two to five participants, as presented in Table 1. In the group with only two participants additional members were listed, but unfortunately they were unable to attend because of prioritized work events. Two to three focus groups are said to be enough for more than 80% of all themes to be discovered, and three to six focus groups enough to discover 90%.[40] Dropout is a known problem in this type of data collection,[22] but research has shown that even small focus groups with as few as two participants can yield valuable research data.[41] The researchers therefore chose to conduct the focus group interview concerned, despite there being only two participants. Rich data were collected from this occasion and included in the analysis. In the last focus group interview conducted, only a few new views of smart glasses were expressed. This indicates that sufficient content richness was obtained.[40] The average interview duration was 35 minutes; the focus group interview with only two

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participants lasting 23 minutes was the shortest. During the analysis it became clear that the authors had not explained to the participants whether smart glasses were to be used as a supplement to, or to replace, existing monitoring equipment. This may have affected the participants' responses. The researchers conclude that both the number of focus group interviews and the number of participants sufficed for collection of rich data for analysis.

The participants' workplace was the same as the first author's. This may weaken the findings, owing to previous interactions between the author and the participants. This may have meant that, because of earlier relationships, participants answered questions in ways that were beneficial or not beneficial to the author, rather than expressing their sincere opinions.[22] However, this effect is relatively unlikely because the first author neither moderated the discussions nor had a leading role in the workplace.

A theme may be difficult to discover but obvious once detected.[39] In this study, working on the thematic process separately, the first and second authors identified the same theme. To increase credibility continuous tutorials with and assessments by impartial researchers took place.[22,23]

Conclusions and Implications for Practice

This study reports views of anesthesia health care professionals, including anesthesiologists and NAs, on smart glasses before clinical use in anesthesia care. Overall, most of the participants had positive views of the smart glass technology. Smart glasses were seen as a tool that could facilitate health care professionals' strive to gain a feeling of situational control in anesthesia care. The findings also show that smart glasses can impact and improve the presence of patient-related information. These are factors that can increase patient safety. Some issues related to the potential clinical use of smart glasses, such as technical limitations and effect on users, need further attention. Findings from this study can help provide application developers with the information they require to develop a customized application for smart glasses in anesthesia care. These findings also indicate that NAs and anesthesiologists believe that smart glasses could be a part of future anesthesia care. To find out if this is true, clinical tests using smart glasses with a customized application are needed.

Acknowledgments

The authors wish to thank the participants for their valuable contributions. The authors would also like to thank the manager of the OR for allowing focus group interviews during working hours. Finally, the authors would like to thank the Smart Use of Communication in Complex Care Environments (SUCCCE) project for providing smart glasses for use during the interviews.

References

1. Staender S, Mahajan RP. Anesthesia and patient safety: Have we reached our limits? *Curr Opin Anesthesiol*. 2011;24:349–353.
2. Steadman J, Catalani B, Sharp C, Cooper L. Life-threatening perioperative anesthetic complications: Major issues surrounding perioperative morbidity and mortality. *Trauma Surg Acute Care Open*. 2017;2:1–7.
3. National Institute of General Medical Science. *Science education: Anesthesia*. 2017. Available at: https://www.nigms.nih.gov/education/pages/factsheet_anesthesia.aspx. Accessed August 20, 2019.
4. De La Cruz Monroy M, Mosahebi A. The use of smartphone applications (apps) for enhancing communication with surgical patients: A systematic review of the literature. *Surg Innov*. 2019;26:244–259.
5. Cooper JB, Newbower RS, Long CD, McPeek B. Preventable anesthesia mishaps: A study of human factors. *Anesthesiology*. 1978;49:399–406.
6. Staender S, Smith A. Enhancing the quality and safety of the perioperative patient. *Curr Opin Anesthesiol*. 2017;30:730–735.
7. Doyle JD, Dahaba AA, Le Manach Y. Advances in anesthesia technology are improving patient care, but many challenges remain. *BMC Anesthesiol*. 2018;18:1–5.
8. Bainbridge D, Martin J, Arango M, Cheng D. Perioperative and anesthetic-related mortality in developed and developing countries: A systematic review and meta-analysis. *Lancet*. 2012;380:1075–1081.
9. Peden CJ, Campbell M, Aggarwal G. Quality, safety, and outcomes in anesthesia: What's to be done? An international perspective. *Br J Anesth*. 2017;119(suppl 1):i5–i14.
10. Kolodzey L, Grantcharov PD, Rivas H, Schijven MP, Grantcharov TP. Wearable technology in the operating room: A systematic review. *BMJ Innov*. 2016;0:1–9.
11. Dougherty B, Badawy SM. Using Google glass in nonsurgical medical settings: Systematic review. *JMIR Mhealth Uhealth*. 2017;5:1–22.
12. Wei NJ, Dougherty B, Myers A, Badawy SM. Using Google glass in surgical setting: Systematic review. *JMIR Mhealth Uhealth*. 2018;6:1–15.
13. Maruyama K, Watanabe E, Kin T, et al. Smart glasses for neurosurgical navigation by augmented reality. *Oper Neurosurg*. 2018;15:551–556.
14. Boillat T, Grantcharov P, Rivas H. Increasing completion rate and benefits of checklists: Prospective evaluation of surgical safety checklists with smart glasses. *JMIR Mhealth Uhealth*. 2019;7:e13447.
15. Romare C, Skär L. Smart glasses for caring situations in complex care environments: Scoping review. *JMIR Mhealth Uhealth*. 2020;8:e16055.
16. Liu D, Jenkins SA, Sanderson PM, Fabian P, Russell JW. Monitoring with head-mounted displays in general anesthesia: A clinical evaluation in the operating room. *Anesth Analg*. 2010;110:1032–1038.
17. Mitrasinovic S, Camacho E, Trivedi N, et al. Clinical and surgical applications of smart glasses. *Technol Health Care*. 2015;23:381–401.
18. Romare C, Hass U, Skär L. Healthcare professionals' views of smart glasses in intensive care: A qualitative study. *Intensive Crit Care Nurs*. 2018;45:66–71.
19. Morton PG, Fontaine DK. *Critical Care Nursing: A Holistic Approach*. Philadelphia PA: Wolters Kluwer; 2018.
20. Nagelhout J, Elisha S. *Nurse Anesthesia*. St Louis, MO: Elsevier; 2017.
21. Husnain Iqbal M, Aydin A, Lowdon A, et al. The effectiveness of Google GLASS as a vital signs monitor in surgery: A simulation study. *Int J Surg*. 2016;35:293–297.
22. Polit DF, Beck CT. *Nursing research: Generating and Assessing Evidence for Nursing Practice*. Philadelphia PA: Wolters Kluver; 2016.
23. Granheim UH, Lundman B. Qualitative content analysis in nursing research: Concepts, procedures and measures to achieve trustworthiness. *Nurse Educ Today*. 2004;24:105–112.
24. World Medical Association. *WMA Declaration of Helsinki. Ethical principles for medical research involving human subjects* [Updated July 9, 2018]. 2013. Available at: https://www.wma.net/policies-post/wma-declaration-of-helsinki-ethical-principles-for-medical-research-involving-human-subjects/. Accessed August 20, 2019.
25. Sapolsky RM. *Why Zebras Don't Get Ulcers*. New York, NY: WH Freeman and Company; 1998.
26. Verma R, Mohan B, Pal Attri J, Cahtrath V, Bala A, Singh M. Anesthesiologists: The silent force behind the scene. *Anesth Essays Res*. 2015;9:293–297.
27. Fernández A, Usamentiaga R, Carús JL, Casado R. Driver distraction using visual-based sensors and algorithms. *Sensors*. 2016;16:1805.
28. Van Pelt M, Weinger MB. Distractions in the anesthesia work environment: Impact on patient safety? Report of a meeting sponsored by the anesthesia patient safety foundation. *Anesth Analg*. 2017;125:347–350.
29. Merry AF, Webster CS, Hannam J, et al. Multimodal system designed to reduce errors in recording and administration of drugs in anesthesia: Prospective randomized clinical evaluation. *Br Med J*. 2011;343:d5543.
30. Almerud-Östberg S. Visualism and technification—The patient behind the screen. *Int J Qual Stud Health Well-Being*. 2010;5.
31. Sabzevari S, Mirzaei T, Bagherian B, Iranpour M. Critical care nurses' attitudes about influence of technology on nursing care. *Br J Med Med Res*. 2015;9:1–10.
32. Tunlind A, Granström J, Engström Å. Nursing care in a high-technological environment: Experiences of critical care nurses. *Intensive Crit Care Nurs*. 2015;31:116–123.
33. Swedish National Association for Anaesthesia and Intensive Care and Swedish Society of Nursing. *Description of Competence for Registered Nurse with Graduate Diploma in Specialist Nursing—Intensive Care*. Stockholm, Sweden: Swedish National Association for Anaesthesia and Intensive Care and Swedish Society of Nursing; 2012.
34. Swedish National Association for Anaesthesia and Intensive Care and Swedish Society of Nursing. *Description of Competence for Registered Nurse with Graduate Diploma in Specialist Nursing—Anesthesia Care*. Stockholm, Sweden: Swedish National Association for Anaesthesia and Intensive Care and Swedish Society of Nursing; 2019.
35. Sundqvist A-S, AnderzénCarlsson A. Holding the patients' life in my hands: Swedish registered nurse anesthetists' perspective of advocacy. *Scand J Caring Sci*. 2014;28:281–288.
36. Aagaard K, Elgaard Sorensen E, Rasmussen BS, Laursen B. Identifying nurse anesthetists' professional identity. *J Perianesth Nurs*. 2017;32:619–630.
37. Ervin EN, Kahn JM, Cohen TR, Weingart LR. Teamwork in the intensive care unit. *Am Psychol*. 2018;73:468–477.
38. Elo S, Kyngäs H. The qualitative content analysis process. *J Adv Nurs*. 2007;62:107–115.
39. Granheim UH, Lindgren B-M, Lundman B. Methodological challenges in qualitative content analysis: A discussion paper. *Nurse Educ Today*. 2017;56:29–34.
40. Guest G, Namey E, McKenna K. How many focus groups are enough? Building an evidence base for nonprobability sample size. *Field Methods*. 2016;29:3–22.
41. Toner J. Small is not too small. Reflections concerning the validity of very small focus groups. *Qual Social Work*. 2009;8:179–192.

Please cite this article as: Enlöf P et al., Smart Glasses for Anesthesia Care: Initial Focus Group Interviews with Specialized Health Care Professionals, Journal of PeriAnesthesia Nursing, https://doi.org/10.1016/j.jopan.2020.06.019