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A Delphi study identifying operating room nurses' non-technical skills

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Abstract

Aim: To identify the non-technical skills of operating room nurses. This is the first empirical study that includes scrub and circulating operating room nurses.

Design: A three-round modified online Delphi technique was used for this study.

Methods: Eligible participants ($n = 106$) with a minimum of 2 years of operating room nursing experience were selected for the expert panel by self-recruitment from a population ($N = 1640$) of operating room nurses. Data were collected through online surveys, based on crew recourse management theory, between April and September 2020. Descriptive statistics analysis was used for the quantitative data, and deductive thematic analysis for the qualitative data. Consensus was determined using stability between the survey rounds.

Results: A consensus was obtained to maintain the non-technical skills categories of situation awareness, leadership, decision-making, communication and teamwork. The qualitative data revealed several novel non-technical skills, including independent decision-making and leadership skills.

Conclusion: The non-technical skills of operating room nurses are more extensive than previously identified. This study has contributed to a verbalization of the tacit knowledge and skills of the operating room nurses. In addition, a list of non-technical skills that should be included in the education of operating room nurses to ensure patient safety in the operating room has been prepared.

Impact: This study addresses the lack of research on the non-technical skills of operating room nurses. When exploring the non-technical skills of scrub and circulating nurses, a diversity of novel non-technical skills was uncovered. This research will provide input for the development of a new training, supervision and assessment tool for accelerated development of the non-technical skills of operating room nurses. This contribution to the verbalization of the formerly tacit non-technical skills may facilitate clinical and formal teaching of such skills and may subsequently impact surgery-related patient safety.

KEYWORDS
circulating nurse, crew resource management, Delphi study, Delphi technique, non-technical skills, operating room nursing, patient safety, perioperative nursing, scrub nurse

1 | INTRODUCTION

Operating room (OR) nursing is responsible for the delivery of safe and efficient perioperative care, and prevention of adverse effects being inflicted on the patient (Goodman & Spry, 2017). The profession is complex. Moreover, the OR nurses must adhere to standards and recommendations, show a high level of technical and non-technical skills, and follow ethical and professional guidelines to deliver high-quality care (Kelvered et al., 2012). Most of these competencies are well covered in the OR nursing tradition, education and research, but the non-technical skills have, until recently, suffered from a lack of attention (Levada et al., 2018). Non-technical skills can be defined as 'the cognitive, social and personal resource skills that complement technical skills, and contribute to safe and efficient task performance' (Flin et al., 2008). Skills similar to non-technical skills were described as early as 1859 by Nightingale in 'Notes on nursing' (Nightingale, 2018). This illustrates that non-technical skills are not novel skills, but what the best practitioners perform consistently to achieve high quality in their OR nursing (Flin et al., 2008).

2 | BACKGROUND

2.1 | Perioperative nursing

Perioperative nursing comprises pre-, intra- and postoperative nursing. The OR nurse is responsible for nursing in the intraoperative period, or the time from transfer of the patient to the operating table to the time at which they are admitted to the recovery area (Goodman & Spry, 2017). OR nursing comprises two roles: the scrub (or instrument) nurse who drapes the patient, administers the instruments and serves the surgeon and the circulating (or floor) nurse who positions and disinfects the patient, facilitates the surgical team, manages activities outside the sterile field and serves as the patient's advocate (Goodman & Spry, 2017). There is no international agreement on the education and competence of OR nurses, and the qualifications required for working in the OR span from technical and preregistration nursing to postgraduate or master's degree specialized OR nursing.

In Norway, postgraduate college- or university-level education, or a master's degree in OR nursing is required for working in the OR. Through their education, the OR nurses develop proficiency in the roles of both scrub and circulating nurses and it is customary to alternate between the roles throughout the day. Norway has a public health system, with three main levels of public hospitals. The university hospitals are large teaching hospitals, with trauma, acute and elective surgical procedures. The smaller regional hospitals have limited teaching responsibilities and provide acute and elective surgical procedures. The surgical facilities at the local hospitals provide elective surgery, often in a limited range of specialities. Because of a small and widespread population, there is a low degree of specialization of hospitals. Thus, the OR nurse usually work in several surgical specialities in one surgical unit. The availability of auxiliary personnel is limited; thus, the OR nurse have the competence and responsibility to handle medical technology and radiology equipment.

Traditionally, the non-technical skills complementing the technical skills of OR nurses are described as the demonstration of tacit and clinical knowledge, and these skills are believed to develop over time through experience, not through education. The nature of OR nursing being performed in 'closed quarters' may have contributed to defining the skills as tacit, since the skills of the OR nurses is kept in the profession and not verbalized outside the operating department. Because this set of skills is traditionally considered tacit, the vocabulary needed to describe and teach the non-technical skills is underdeveloped (Sirevåg et al., 2021). Previous studies showed that the development of non-technical skills may be accelerated using systematic training (McClelland, 2015). Thus, raising the question if the skills are indeed tacit, or if gaining a vocabulary for non-technical skills may transfer some of the knowledge from tacit to teachable.

2.2 | Non-technical skills and crew resource management:

To facilitate the training of non-technical skills, the crew recourse management (CRM) courses were developed for the aviation industry (Flin et al., 2003), and this management system has subsequently been adapted to other high-risk industries (Flin et al., 2008). Although health care might not be considered an 'industry', it is certainly a high-risk environment, wherein approximately 15% of surgical hospital admissions result in adverse events. A total of 50%–70% of incidents related to the OR are considered preventable and largely caused by lack of non-technical skills in the surgical team (Anderson et al., 2013; Nilsson et al., 2016). Thus, highly developed non-technical skills are needed in the surgical team (Gillespie et al., 2017; Sevdalis et al., 2012), and non-technical skills training should be implemented in the education of OR nurses (Flin & Patey, 2009). Table 1 provides a compilation of non-technical skills categories and elements included in the CRM (Flin et al., 2008). The 'elements' in the CRM are descriptions of non-technical skills. Related elements are grouped in 'categories'. When CRM tools are operationalized for use, behavioural markers illustrating correct or incorrect conduct is given for each element (Thomas, 2018).

Table 1. Non-technical skills categories and elements in crew resource management (Flin et al., 2008).

The CRM training and assessment tools need to be customized according to the identified non-technical skills of the designated profession (Flin et al., 2008; Yule et al., 2017). This has been

TABLE 1 Non-technical skills categories and elements in crew resource management (Flin et al., 2008)

Category	Elements
Situation awareness	Gathering information Interpreting information Anticipating future states
Decision-making	Defining problems Considering options Selecting and implementing option Outcome review
Communication	Sending information clearly and concisely Including context and intent Receiving information Identifying and addressing barriers to communication
Team working	Supporting others Solving conflicts Exchanging information Co-ordinating activities
Leadership	Using authority Maintaining standards Planning and prioritizing Managing workload and resources
Managing stress	Identifying symptoms of stress Recognizing effects of stress Implementing coping strategies
Coping with fatigue	Identifying symptoms of fatigue Recognizing effects of fatigue Implementing coping strategies

performed for the different professions in the OR, that is, the surgeon, anaesthetist and scrub nurse (Glavin & Patey, 2017; Yule et al., 2017). The CRM-based 'Scrub Practitioners' List of Intraoperative Non-technical Skills' (SPLINTS) offers structured observation, rating and feedback of scrub practitioners' (scrub nurse or technician) behaviours in the intraoperative phase (Flin & Mitchell, 2017). However, the SPLINTS has some limitations about applicability in OR nursing. The intraoperative phase is defined as the 'knife-to-skin to close' phase of surgery (Mitchell et al., 2011), which differs from the profession's definition of this phase. This difference results in the exclusion of preparation for surgery and patient handover, which are recognized as essential for patient safety. The SPLINTS only captures the performance of scrub nurses, and not of circulating nurses (Mitchell et al., 2011). This is questionable because previous studies identified that the circulating OR nurses also use non-technical skills (Gillespie et al., 2009; Redaelli, 2018). Moreover, by identifying and ameliorating minor errors during surgery, the circulating nurses play a vital role in maintaining patient safety (Yang et al., 2012). The identification of the non-technical skills to be included in the SPLINTS was based on interviews of OR nurses and surgeons, wherein the opinions of the surgeons were given preference over those of the nurses. These limitations, along with catering assessment rather than teaching, may be reasons for a lack of published implementation studies of the SPLINTS instrument. The limitations may also serve as a motivation for increased research about the non-technical skills of OR nurses in the profession. A new CRM training, supervision and assessment tool for OR nurses need to be developed based on non-technical skills of scrub and circulating OR nurses during the entire intraoperative phase. Such a tool should cater to the needs of OR nurses and be compatible with the existing tools for the other members of the surgical team to promote team non-technical skills.

3 | THE STUDY

3.1 | Aim

This study aimed to identify the non-technical skills of OR nursing. This study is the first part of a doctoral study. Using the Delphi technique, which is a mixed method, the following quantitative and qualitative research questions were addressed:

Quantitative:

- Which non-technical skills categories are considered essential by Norwegian OR nurses?
- How do the OR nurses rate the importance of each non-technical skill?

Qualitative:

- How do the OR nurses describe their non-technical skills?

3.2 | Design

A descriptive design, using the Delphi technique, was selected to identify the non-technical skills of OR nurses. The Delphi technique is suitable to

uncover the 'tacit' knowledge of non-technical skills because it can capture collective knowledge that is not often verbalized, and is also considered suitable for areas with a lack of empirical data (Foth et al., 2016; Whitehead & Day, 2016). The main assumption of the Delphi technique is that group consensus is more valid than individual opinion. Therefore, the Delphi technique is useful for achieving agreement among expert OR nurses on the issue of non-technical skills, where no agreement previously existed (Keeney et al., 2011). The Delphi technique has a mixed-methods design, and both qualitative and quantitative techniques are used to collect and analyse data (Whitehead & Day, 2016). Consensus on the category level was defined as stability between survey rounds rather than the classical percentage of agreement (Keeney et al., 2011; Powell, 2003). This was assumed appropriate because only seven categories were considered. Consensus on element level was predefined by scores on a 9-points Likert-type scale and mean usage:

- Consensus to exclude element: a mean importance-score of 3 and below, and/or a mean usage of never or rarely
- Consensus to include element: a mean importance-score of 7 and up, and a mean usage of weekly or daily
- Re-rating required for elements with a mean importance of between 3,1 and 6,9

The number of rounds necessary was determined by the level of consensus (Keeney et al., 2011).

3.3 | Sample

The nature of the Delphi does not provide directions of justification of sample size. In previous research and methodological literature, a panel size between five and thousands has been used. Thus, we have made our decision on a panel size of 100 based on Keeney et al. who emphasizes that the size must be balancing the ability to generate a definite conclusion and the difficulty of managing a larger panel size (Keeney et al., 2011). It is suitable for a Delphi panel to include experts who are likely to use the end product. Thus, expertise was defined by profession and clinical experience (Keeney et al., 2011; McMillan et al., 2016). The general population for this study was the OR nurses in Norway. All members of the Norwegian Association for Operating Room Nurses (NAORN), $N = 1640$, were invited. Membership in the NAORN may be an indication of interest in professional development and quality improvement. They were all registered nurses with an additional 1.5-year postgraduate or 2-year masters' degree in OR nursing.

The inclusion criteria for the panel in survey round I were:

1. Currently in active duty as OR nurse
2. Minimum two years post-training experience
3. Willingness to complete all Delphi rounds

The inclusion criterion for the panel in subsequent rounds was completion of the previous round(s).

The NAORN distributed the invitation, and the participants actively chose to participate via a registration link; thus, the sample is not randomized. In 2 weeks, 106 participants were accepted to allow for attrition due to incomplete surveys or non-compliance with the inclusion criteria. Following a quality check of the surveys, all 106 were included in round I.

3.4 | Data collection

An invitation email was distributed by the NAORN to all members ($N = 1650$). The email contained information on the inclusion criteria and a link to the study. On activating the link, an exclusive participant number was generated, and the survey was distributed automatically by email. All survey rounds included a formal letter of invitation and information, and informed consent had to be provided to activate the survey.

3.4.1 | Survey round I

The surveys were created using the online survey software SurveyXact 12.9 (Ramboll management Consulting, www.surveyxact.dk). The first section of the survey collected demographic data of the panel members. This study was a modified Delphi study, thus, the classical first round of idea generation was replaced by statements developed from the existing CRM literature (Table 1) (Flin et al., 2008; Keeney et al., 2011). An alphabetical list of the non-technical skills *categories* was presented in the second section of the survey, and the experts were asked to select the most important category and elaborate on their choice in an open question. In the third section, they were asked to rate each non-technical skills *element* according to the level of importance for OR nursing on a 9-point Likert-type scale (McMillan et al., 2016). They were also asked to report how often they used the non-technical skills element (never, rarely, monthly, weekly or daily), and to elaborate on the use of each element in open ended text boxes. At the end of the survey, they were encouraged to provide feedback to promote interaction between the researchers and informants (McMillan et al., 2016).

The prepared survey was subjected to a technical and methodical test ($n = 4$ academics) before a pretest with OR nurses who met the inclusion criteria ($n = 15$). The academics' testing revealed the survey to be time-consuming, thus, the free text elaboration on element level was removed. Extensive testing identified word ambiguity and technical issues and served as a functionality control of the administrative system (SurveyXact). Some minor adjustments were made following the pretest in areas where ambiguity was revealed. The pretest determined a completion time for the survey of 20–30 min, which is within that recommended in the literature (Keeney et al., 2011). The participants in the pretest were excluded from participating in this study.

3.4.2 | Survey round II

Following the intentions of a Delphi study, the analysis of round I led to some alterations in round II (Keeney et al., 2011; Whitehead & Day, 2016). The survey started with complementary demographic questions followed by a presentation of the distribution of non-technical skills categories from round I. Each participant was also reminded of their answer. Based on feedback, the panel was asked to select the three most important categories of non-technical skills. The analysis revealed that the elaboration on the clinical use of non-technical skills at the element level (removed after pretest) was necessary. To maintain the completion time to below 30 min, the survey only presented element-level questions belonging to the three selected categories. After being provided with a personal and mean panel rating for each element from round I, the participants had the option to re-rate the elements and to elaborate on their ratings (McMillan et al., 2016). The response time for round II was increased from the 2 weeks recommended to 4 weeks due to the ongoing coronavirus disease 2019 pandemic. Weekly reminders were distributed exclusively to those who had not responded (Keeney et al., 2011).

3.4.3 | Survey round III

Based on the analyses of rounds I and II and the consensus criteria, two categories were excluded from the non-technical skills category rating in round III. The panel was asked to place the remaining five categories in a prioritized order (click and drag). The element-level ratings were excluded from round III due to the inconclusive nature of the ratings in round I and II. It was decided that an extra round of rating would not contribute to further clarity. The complete content of all surveys was translated to English and made accessible in appendices 1–3.

3.5 | Ethical considerations

This research was approved by the Norwegian Social Science Data Service, reference number: 155726, and was conducted according to the ethical principles of the Declaration of Helsinki and the National Research Legislation (The Norwegian National Research Ethics Committees, 2019; World Medical Association, 2013). All potential participants received written information about the aim of the study and the extent of their contribution. They were informed that the participation was voluntary and that they were free to withdraw from the study at any time without ramifications. All identifiable and unidentifiable data were stored according to the guidelines provided by the Norwegian Social Science Data Service. Although anonymity between the panel members were assured, the nature of the Delphi study, wherein the researchers provide personalized feedback in subsequent rounds, hinders anonymity between the researchers and participants. All data were separated from identifying characteristics before analysis to achieve confidentiality in the absence of anonymity (Keeney et al., 2011; Polit & Beck, 2017).

4 | DATA ANALYSIS

4.1 | Quantitative analysis

The demographic data were analysed using SurveyXact to describe the variance in the population. The remaining quantitative data for each round were exported from SurveyXact to IBM SPSS Statistics (version 26; IBM SPSS). Descriptive analysis was performed for each round separately to form a frequency table of the statements (Keeney et al., 2011). The levels of consensus at category and element levels were considered for each round. As previously described, the panel members were asked to select one category in round I, and the three most essential categories in round II, and in the final round they were asked to arrange the remaining five categories according to importance. Thus, a calculation was necessary to compare the distribution (Appendix 4).

4.2 | Qualitative analysis

The qualitative data (36500 words) were exported from SurveyXact to Nvivo 12 Pro (Alfasoft, www.alfasoft.com) and a deductive analysis was performed (Figure 1) following the seven steps of thematic analysis (Braun & Clarke, 2013).

The themes were developed based on selective coding of descriptions of non-technical skills. Themes with similar content were merged into main themes corresponding to the categories of the CRM. The resulting thematic map is provided in Appendix 5. Subsequently, the main themes, themes and codes will be used in the development of a new CRM-based training, supervision and assessment tool. During the initial steps of the analysis, it became apparent that the material was surprisingly rich in content. It was decided to also perform an inductive thematic analysis, which will be published in a separate article.

4.3 | Validity and reliability/Rigour

Because of the mixed-method design of Delphi studies, a debate concerning documentation of rigour in such studies is ongoing. In addition, few methodological guidelines on rigour are available, and thorough documentation of rigour is scarce in study reports. In this study, rigour will be demonstrated through reliability and validity as well as trustworthiness (Hasson & Keeney, 2011; Keeney et al., 2011).

4.3.1 | Reliability

This survey was developed through two pretest rounds. Extensive testing provided information about reliability as the pretest participants answered in accordance with the intention (Keeney et al., 2011). When the pretest revealed ambiguity, questions were

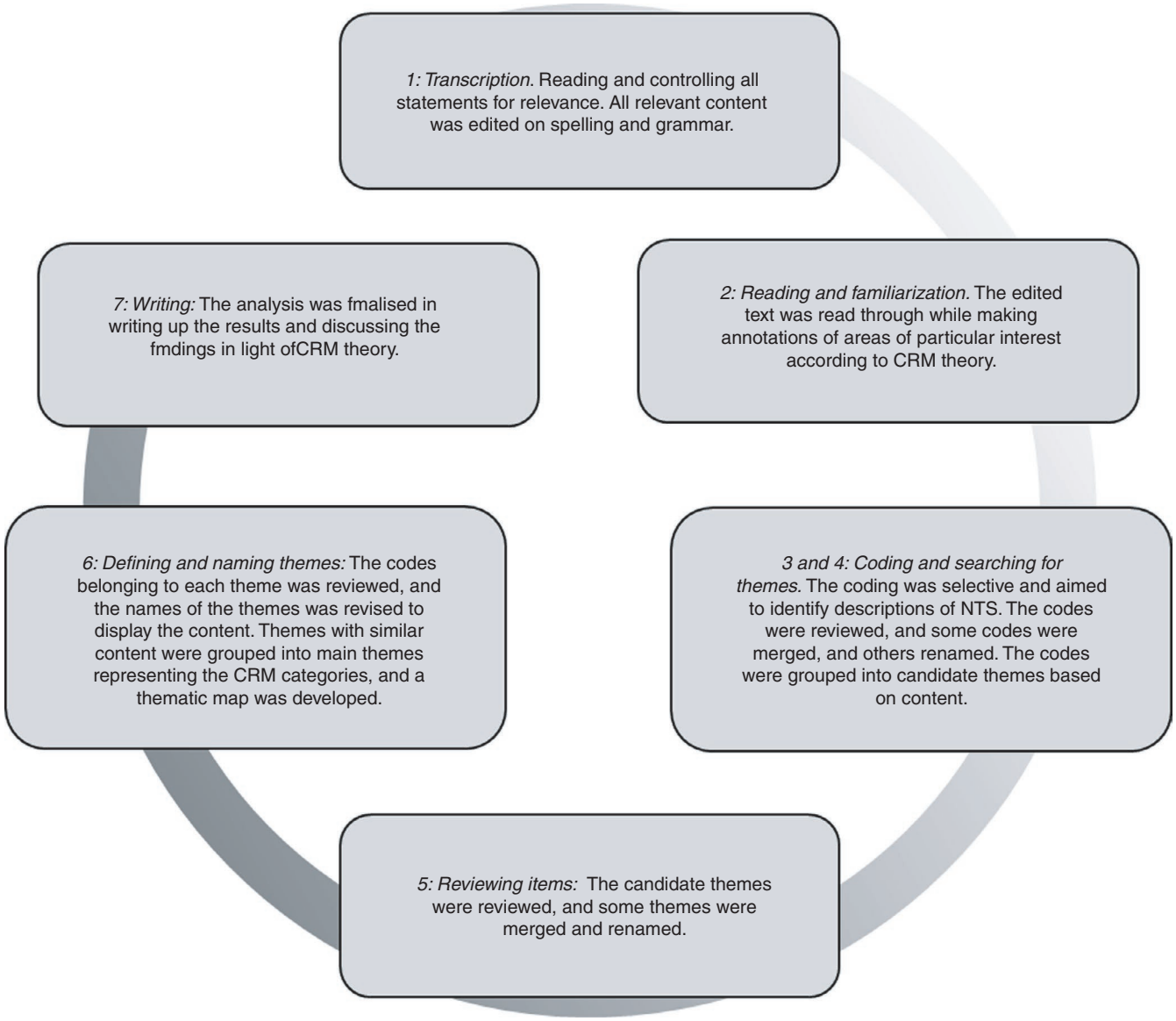

FIGURE 1 The process of deductive thematic analysis

rephrased to establish the reliability of the survey. Reliability was maintained during each round, because the participants checked and provided feedback that the interpreted data were consistent with their responses and the overall positions on the topic (Keeney et al., 2011; Whitehead & Day, 2016).

4.3.2 | Validity

Content validity was enhanced through demographic variance along with panel size, where a sound demographic distribution confirms that the panel size was sufficient (Keeney et al., 2011). The panel was comprised of highly experienced OR nurses, and based on the variance, they were considered representative, which broadens the generalizability of the findings (Keeney et al., 2011). No partiality should have occurred when selecting the non-technical skills, because the lists presented in the survey were either alphabetical or randomized for each participant. The results were validated throughout the Delphi process when the panel members were provided feedback through group mean and personal ratings in personalized surveys and provided the opportunity to re-rate or comment. The high response rate is supportive of the validity in a Delphi study (Hasson et al., 2000).

4.3.3 | Trustworthiness

The credibility of this Delphi study is enhanced by providing transparency in decisions about expert panel selection, data collection and consensus criteria (Powell, 2003). The surveys of all three rounds are provided as supporting information to enhance transparency. The consensus criteria at category and element levels were predetermined. The ongoing iteration and feedback process was also considered to enhance credibility because it can be viewed as a member check (Hasson & Keeney, 2011). Dependability was achieved by

including a representative sample of experts in the panel (Hasson & Keeney, 2011). The Delphi approach is free of group bias because of the anonymity between panel members. The size of the panel should ensure that a single opinion will not overpower the group, which could be the case in a group interview. The qualitative answers serve as a control that the questions are understood, and that the survey is answered by an OR nurse. Confirmability was assessed by providing a detailed description of data collection and analysis, and by providing supplementing documents as appendices (Hasson & Keeney, 2011). Although the level of transferability to international settings must be determined by the reader, we have aimed for transparency in all areas. The inclusion criteria are presented, and although the selection of participants was not randomized, the self-inclusion was not controlled by the researchers. The representativeness of the panel is illustrated by the demographic information of the participants and hospital settings. We believe that the findings in this study are applicable for OR nurses with similar education and responsibilities worldwide.

5 | RESULTS

5.1 | Response rate

Round I achieved the required number of respondents, and a total of 106 panel members representing the 1640 invited OR nurses. The response rate was 90.6% in round II, and 84.4% in round III, which is well over the minimum of 70% suggested in the literature (Keeney et al., 2011). Details of the recruitment and response rates are provided in Figure 2.

5.2 | Demographics

The panel members' experience in OR nursing spanned from 3 to 38 years with a mean of 24.2 years after completion of master's degree or postgraduate college education in OR nursing; thus, supporting their status as experts in clinical OR nursing.

Their geographical distribution matches the distribution of the Norwegian population. Work hours in Norway are highly regulated, and there are three 8-h shifts in 24 h. A total of 42% of the participants had daytime positions, while 53% had evenings and/or night shifts included in their work schedule. Furthermore 79% of the participants had full time employment, and 48% worked more than full time. Most of the panel members worked in an operating department (79%) at university or regional hospitals. Table 2 provides detailed information on demographics.

5.2.1 | Survey Round I

The quantitative ratings at category and element levels in all rounds are presented in Table 3. The CRM categories that were considered most important in OR nursing in round I were 'Teamwork' (38%), 'Communication' (29%) and 'Situation awareness' (27%). No relevant difference was observed between the ratings of elements belonging

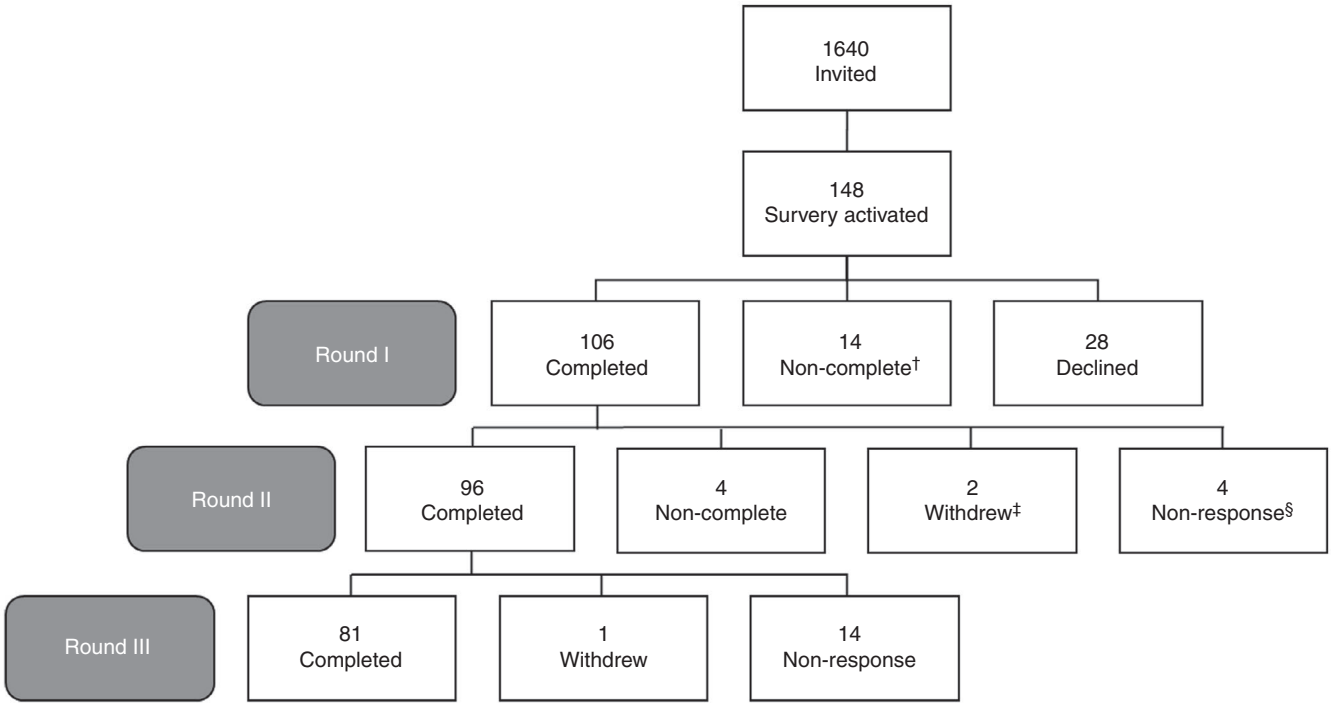

FIGURE 2 Recruitment and completion of the Delphi rounds. †Represents participants who started the survey without completing it. ‡Represents participants who declined to provide consent or requested to withdraw from further participation. §Represents participants who did not start round II or III surveys

TABLE 2 Participant demographics, *N* = 106 unless otherwise is stated

Geographical distribution	South-East		West		Central		North
General population of Norway[a], *n* (%)	2900000 (56)		1100000 (21)		700000 (14)		480000 (9)
Panel members (*N* = 96), *n* (%)	52 (54)		21 (22)		16 (17)		7 (7)
Years of experience	2–7 years		8–14 years		14–24 years		25+ years
n (mean)	25 (4.4)		22 (10.7)		29 (19.1)		30 (30.4)
Gender	Female		Male		No answer		
Members NAORN, *n* (%)	1576 (96.1)		64 (3.9)				
Participants, *n* (%)	100 (94.3)		5 (4.7)		1 (0.9)		
Principal area of employment	University Hospital		Regional Hospital		Local Hospital		Private facility/ other
Type of ward	OD[b]	Outpatient	OD	Outpatient	OD	Outpatient	
n (%)	36 (34)	7 (7)	41 (43)	10 (9)	4 (4)	0 (0)	6 (6)
Work schedule	Day		Day/evening		day/evening/night		Other
n (%)	45 (42)		10 (9)		47 (44)		4 (4)
Work hours	0–49%		50–74%		75–100%		>100%
Position, percentage of full time[c] (*N* = 96), *n* (%)	3 (3)		3 (3)		90 (94)		
Actual work, percentage of full time, *n* (%)	2 (2)		5 (5)		48 (45)		51 (48)

[a]Population numbers retrieved from the Norwegian government, www.regjeringen.no/no/dokumenter/nou-2016-25/id2522062/sec9.

[b]Operating department.

[c]100% work position equals 37 h/week in daytime poitions, and 35.5 h/week for shift workers.

to the three most important categories (mean = 8.14) and the other categories (mean = 7.60). This finding may have been caused by the Hawthorne effect (Polit & Beck, 2017).

However, there was a tendency for increased ratings of elements with a reported frequency of daily or weekly use compared with those of elements that were never or rarely used (Figure 3).

Four categories received 3% or less support in round I. The low importance-score was contradicted in the qualitative elaborations. Thus, it was decided to include all categories in round II. The elaborations provided useful feedback, which was used to modify the survey for round II. The results of round I did not support the exclusion of any categories or elements for round II.

5.2.2 | Survey round II

The three categories that were considered most important were the same in the first two rounds. Moreover, the two categories 'Managing stress' and 'Coping with fatigue' had limited or no importance. However, the consensus criteria were not met, and a third round was considered necessary. Based on marginal ratings in rounds, I and II these two categories were excluded in round III.

In round II, for each element-related question, the individual response and group mean from Round I were presented to the participant with an option to reconsider their answer. The response for the category 'Leadership' was the most frequently altered response, which is consistent with the observed increase in the importance percentage for this category from 0% to 12%. Similar to round I, a low degree of differentiation was observed between the importance of each element. Thus, these results are considered inconclusive, and ratings at the element level were omitted for round III.

The panel was provided with the option of qualitative elaborations for each element. Results from the deductive thematic analysis are presented below according to the main themes, which correspond to the categories of the CRM. The themes represent non-technical skills described by the panel members. Representative quotes from the expert panel illustrate each main theme.

Situation awareness

> All decisions regarding the patient and the team are based on situation awareness: What equipment I prepare, how I position and drape the patient, and how I prepare for the unexpected. We create a common understanding of the situation by communicating and planning with the rest of the team. Surgical time-out helps us to build a shared situation awareness. It is important to prevent adverse events and increase patient safety.

Themes representing the identified non-technical skills are the following:

- Uses all senses to gain situation awareness
- Is attentive and maintains situation awareness
- Contributes to shared situation awareness

TABLE 3 Quantitative results all rounds

	Round I, *N* = 106 Element scores for all categories		Round II, *N* = 96 Element scores given for 3 chosen categories					Round III, *N* = 81
CRM category CRM element	Category, distribution	Element, mean (SD)	Category, distribution	Element, mean (SD)	*n*	Rerated[a], *n* (%)	Mean change	Category, distribution
Situation awareness								
Gathering information	27%	8.58 (0.7)	21%	8.61 (0.6)	51	1 (2.0)	+2.0	19%
Interpreting information		8.43 (0.8)		8.41 (0.9)	51	1 (2.0)	+2.0	
Anticipating future states		8.46 (0.7)		8.57 (0.7)	51	4 (7.8)	+2.3	
Decision-making								
Defining problem	3%	7.87 (1.2)	10%	7.96 (1.1)	26	1 (3.8)	+3.0	16%
Considering option		8.08 (1.0)		7.92 (1.2)	26	0	0	
Selecting and implementing option		8.23 (0.9)		8.35 (0.9)	26	0	0	
Outcome review		7.63 (1.3)		7.46 (1.7)	26	0	0	
Communication								
Communicating clearly and concisely	29%	8.43 (0.7)	22%	8.52 (0.8)	58	2 (3.4)	+2.0	22%
Including context and intent		8.49 (0.8)		8.62 (0.8)	58	2 (3.4)	+2.5	
Receiving information		8.61 (0.7)		8.81 (0.5)	58	1 (1.7)	+2.0	
Barriers to communication		7.75 (1.2)		7.84 (1.3)	58	1 (1.7)	+1.0	
Teamwork								
Supporting others	38%	8.12 (1.0)	30%	8.18 (0.9)	72	2 (2.8)	+1.5	25%
Exchanging information		8.36 (1.1)		8.46 (0.9)	72	5 (6.9)	+2.0	
Co-ordinating activities		7.63 (1.3)		7.90 (1.0)	72	8 (11.1)	+2.1	
Solving conflicts		7.70 (1.2)		7.72 (1.2)	72	0	0	
Leadership								
Using authority	0%	6.94 (1.7)	12%	7.94 (0.9)	31	9 (29.0)	+2.0	18%
Maintaining standards		8.17 (1.2)		8.45 (0.9)	31	7 (22.6)	+2.1	
Planning and prioritizing		8.25 (1.2)		8.48 (0.8)	31	2 (6.5)	−2.5	
Managing workload and resources		7.20 (1.7		7.68 (1.3)	31	3 (9.7)	+3.0	
Managing stress								

(Continues)

TABLE 3 (Continued)

	Round I, N = 106 Element scores for all categories		Round II, N = 96 Element scores given for 3 chosen categories					Round III, N = 81
Identifying causes of stress	3%	7.42 (1.4)	5%	7.80 (1.0)	10	1 (10.0)	+2.0	n/a
Recognizing symptoms and effects		7.58 (1.3)		7.70 (1.3)	10	1 (10.0)	+2.0	
Coping with stress		8.14 (1.2)		8.60 (0.5)	10	1 (10.0)	+2.0	
Coping with fatigue								
Identifying symptoms and effects	0%	6.73 (1.7)	0%	8.00 (0.0)	1	0	0	n/a
Coping with fatigue		6.60 (1.9)		7.00 (0.0)	1	0	0	

[a]Represents participants opting to change their rating in round II.

- Has awareness towards wrong information
- Uses awareness, knowledge and experience to be one step ahead.

Decision-making

> Lives depends on us; we make decisions to save lives'. 'We make independent decisions when the patient bleeds unexpectedly, and we have to convert the procedure from laparoscopy to laparotomy.

Themes representing the identified non-technical skills are the following:

- Identifies and solves problems about availability and function of surgical equipment
- Considers the patient's weight, height and condition; access for the surgeon; and available equipment when making decisions about draping
- Considers the patient's weight, height and condition; access for the surgeon; and available equipment when making decisions about surgical positioning,
- Considers urgency of the situation and available resources when selecting and implementing options
- Uses knowledge and experience when selecting and implementing options
- Identifies solutions for efficient conversions of surgical method (laparoscopy to laparotomy)
- Reviews outcomes and reconsiders options continuously.

Communication

> Everything depends on communication. Teamwork, decision making, managing stress, situation awareness and leadership are founded on precise communication.

Themes representing the identified non-technical skills are the following:

- Uses communication techniques appropriate to the situation
- Identifies and reduces barriers to communication.

Teamwork

> Even though we have independent responsibilities, we need to work as a team to achieve our goals and solve problems. We depend on helping each other in all situations and need to have respect for each other's work.

Themes representing the identified non-technical skills are the following:

- Offers practical and emotional support in the team
- Contributes to shared situation awareness by exchanging information
- Co-ordinates activities in the team to promote efficiency.

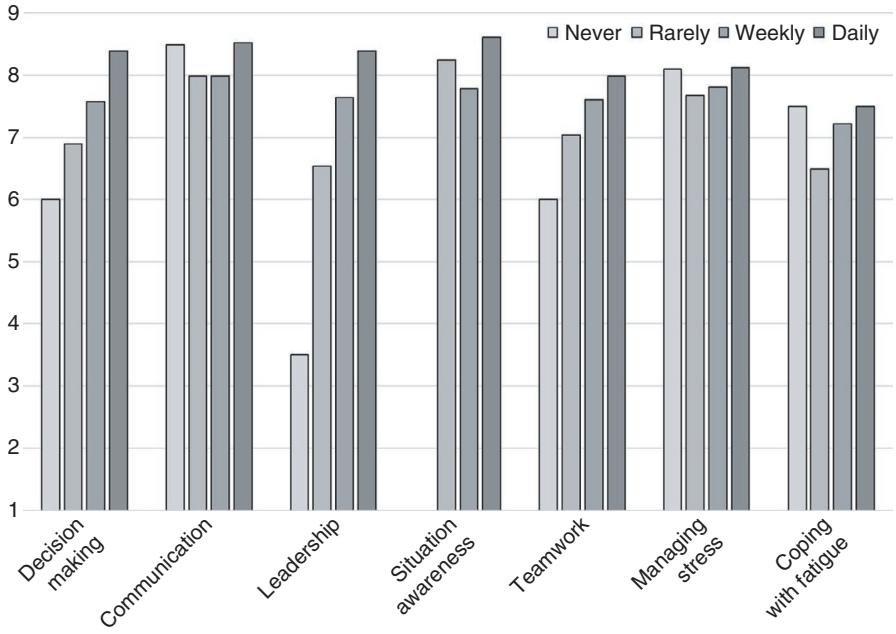

FIGURE 3 Mean scores (1–9) of elements in each category divided by the frequency of use

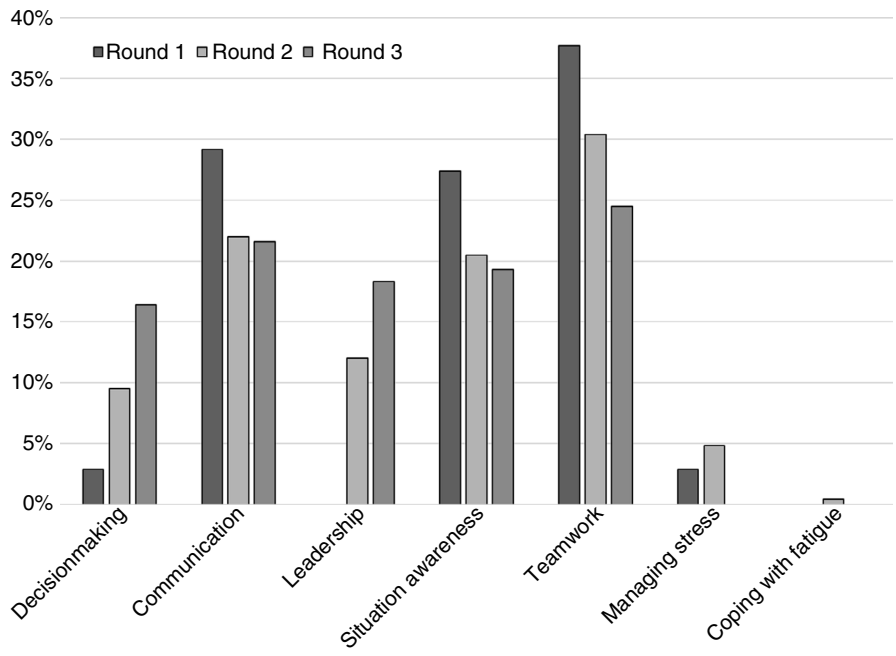

FIGURE 4 Comparison of category importance between rounds

Leadership

The OR nurse plays an important role in the surgical team. We decide when the OR is ready for the patient. We decide when to call the surgeons. We decide when everything is ready for surgery to start. We decide which infection control routines to employ. We use our knowledge of available equipment to decide the order of procedures. Co-operation in the team is essential for efficiency. OR nursing responsibilities are extensive.

Themes representing the identified non-technical skills are the following:

- Uses authority to promote patient safety
- Maintains standards to promote patient safety
- Maintains aseptic surgical field to prevent infections
- Takes responsibility for teaching and supervising others when necessary and appropriate
- Plans single procedures, daily programmes and acute procedures
- Prioritizes activities based on urgency, special considerations, available equipment and competence of OR nurse
- Considers consequences when planning and implementing activities
- Manages the workload of OR nurses to facilitate planned and acute procedures.

Managing stress

> We are prepared to handle unexpected situations. We know what equipment to use and how to use it. We train for the normal and the unexpected, and usually work in pairs, one experienced and one inexperienced OR nurse.

Themes representing the identified non-technical skills are the following:

- Recognizes factors causing stress
- Recognizes effects of stress
- Increases tolerance of stress through competence and debriefing.

5.2.3 | Survey round III

The aim of the third survey was to confirm or reject consensus at the category level based on stability between the rounds. The panel members were presented with personal ratings and group means from round II and asked to arrange the five remaining categories according to importance. The indication of stability between rounds in round II was further supported in round III. Although a flattening of the perceived importance occurred, the three highest-rated categories remained the same (Figure 4). The distinct increase in the importance of 'Decision Making' and 'Leadership' and the decrease in 'Teamwork' may indicate a learning process in the panel, and that the panel members had gained a more nuanced understanding of the non-technical skills through their participation in the study.

5.2.4 | Consensus

The results supported category-level consensus on excluding the categories 'Managing stress' and 'Coping with fatigue'. Stability between rounds was observed, and although 'Managing stress' had a slightly increased importance (from 2.9 to 5%) between rounds I and II, its importance was still significantly lower than that of 'Leadership' (13%) and 'Decision-making' (16%). On considering, it became obvious that 'Managing stress' and 'Coping with fatigue' were not regarded essential by the panel members for their work.

Consensus at the element level cannot be determined based on the Delphi technique. Through rounds I and II, the ratings were high for all elements, and even elements reported to be used rarely or never received high ratings. The qualitative elaborations showed some overlapping with the elements presented in the CRM, but the analysis produced a significant number of novel non-technical skills. All of these novel non-technical skills can be incorporated into the CRM categories determined to be essential to OR nursing; Teamwork, Communication, Situation awareness, Leadership and Decision-making.

6 | DISCUSSION

This study employed the Delphi technique to identify non-technical skills essential for OR nursing. The findings of this study indicates that the inclusion of scrub and circulating OR nurses' non-technical skills in the entire intraoperative phase led to an array of novel skills being identified.

The non-technical skills category of 'Decision-making' received increasing importance throughout the survey. The panel members described extensive decision-making skills, primarily concerning their responsibilities of setting up the OR and positioning and preparing the patient. Moreover, they also considered deciding when to call for backup for inexperienced surgeons and when the patients' best interest requires them to oppose the surgeon's or anaesthetist's opinions as a part of decision-making. This ability to display assertiveness when appropriate has previously been identified in an ethnographic study of circulating nurses (Redaelli, 2018). While previous studies identified scrub nurses' decision-making as 'whether to act or no' (Mitchell et al., 2011), our expert panel described complex autonomous decision-making. To our knowledge, this level of decision-making has not previously been identified. The participating OR nurses were highly educated and had an independent role in the OR. The responses from the participants revealed a low level of hierarchy, which may allow for the OR nurse to make autonomous decisions. When speaking up and suggesting actions contradicting those of the medical staff, the OR nurses emphasized the importance of arguing their stand based on knowledge and experience. The ability to employ their own experience in the discussion was enhanced by the panel members mean experience of 24 years. Novice OR nurses will probably take fewer autonomous decisions due to the lack of experience.

The highest increase in importance was noted for the category of 'Leadership' (from 0% in round I to 18% in round III). This increase is partly caused by the panel gaining a more nuanced understanding of the non-technical skills throughout the surveys. The category-level question was asked to the panel at the start of the survey, and thus in round I, the panel may have perceived 'Leadership' as management. However, a variety of leadership-related non-technical skills was displayed in the qualitative material. The leadership role differs depending on the availability of auxiliary personnel and management. During evening and night shifts, when management is unavailable, the OR team is responsible for all planning and prioritizing. The panel emphasized that although the surgeon and anaesthetist are responsible for medical prioritizing, they are less qualified to consider the availability of equipment or competence of team members. The OR nurses know what equipment is available, and by seeing the bigger picture, they plan and prioritize beyond the current procedure, and their competence in managing the workload may prevent delays and create preparedness for unexpected needs (Gillespie et al., 2009). This differs from the development of the SPLINTS, where leadership was reduced to maintaining standards (Flin & Mitchell, 2017; Mitchell et al., 2011). However, the leadership skill of maintaining standards was also present in our study. A major OR nurse responsibility is to

establish and maintain a sterile field. Thus, the OR nurses ensure that the rest of the team adheres to the standards and use authority towards the team members when necessary. Our panel provided an insight into the motivation for maintaining standards when consistently connecting all leadership non-technical skills to patient safety, such as teaching hygiene standards to others to prevent infection in the patient, and to ensure proper positioning to prevent nerve or pressure injuries. We consider that the inclusion of the circulating nurse, and the expansion of the intraoperative time, contributed to the number of leadership-related non-technical skills uncovered in this study.

The categories of 'Situation awareness', 'Communication' and 'Teamwork' received the highest importance throughout the three rounds of the Delphi. The OR nurse displayed an intuitive understanding of these categories because they are an integrated part of their practice. Traditionally, the ability to stay one step ahead has been the pride of the OR nurses, and thinking ahead or anticipating future states is a frequently identified non-technical skill (Björn & Boström, 2008; Kang et al., 2014; Mitchell et al., 2011; Redaelli, 2018). Our panel used all senses, from hearing, seeing and smelling, to the more elusive gut feeling to gain the awareness needed to stay ahead of the situation. A formerly unidentified situation awareness skill is the awareness towards wrong information. By using their competence, the OR nurses critically evaluate received information and verify it using patient records and information from the patient. This contributes to the rectification of wrongful requests about positioning, missed marking of the surgical site and even wrong patient/procedure incidents. During surgery, the scrub nurse and surgeon have different perspectives of the field. The surgeon focuses on one particular structure, whereas the scrub nurse maintains an overview of the field and can detect issues outside the surgeon's field of vision. By sharing their awareness, the issues can be solved and adverse events prevented. We have not found descriptions of this aspect of situation awareness in previous studies.

During the analysis of the qualitative data, it became obvious that the categories of 'Teamwork' and 'Communication' were particularly intertwined. Some studies reported superficial findings on communication, emphasizing that OR nurses rely on verbal and nonverbal communication for information exchange (Mitchell et al., 2011; Redaelli, 2018). Our participants highlighted the need for adapting their communication techniques according to the situation. They used communication skills ranging from short 'closed-loop' instructions in acute phases to 'small talk' promoting a connection between team members, while being observant of the situation and potential changes in communication requirements. The use of effective communication skills adapted to the situation results in the OR nurse being perceived as a competent team member and leads to effective exchange of information (Gillespie et al., 2009). Teamwork is also enhanced by being attentive to verbal and nonverbal communication about the needs of other team members through open communication, lack of hierarchy and shared understanding (Björn & Boström, 2008). We found several barriers to effective communication that may, if not ameliorated, cause misconceptions, which have an impact on the team's non-technical skills (Gillespie et al., 2017).

Consensus was achieved for excluding the CRM categories 'Managing stress' and 'Coping with fatigue'. These two categories consistently received low importance ratings, and the qualitative data supported the quantitative data. There is a limitation in the survey regarding these categories because the option of re-rating and qualitative elaboration was only offered for the three selected categories. Thus, few qualitative elaborations were obtained for 'Managing stress' ($n = 13$) and 'Coping with fatigue' ($n = 1$).

All panel members were highly educated and had a long experience as an OR nurse. They reported that stress and unforeseen events are expected in the OR and their training prepared them for such situations. This may have contributed to the low scores about stress. It is recognized in the literature that experience may reduce stress (Flin et al., 2008). However, stress-related challenges occur, and this category will be thoroughly discussed in the development of a new non-technical skills training, supervision and assessment tool. The context of this study must be considered when discussing the category of 'Coping with fatigue'. Norway has strict work-hour regulations and strong unions. However, 59% of the participants in full time work normally work overtime, which may indicate the transferability of our findings to settings with longer work hours than those in Norway. Contrary to the findings of Mitchell et al. (2011), our participants did not problematize procedure length. Fatigue caused by lengthy procedures may cause a problem when the OR nurses in the team have different qualifications. OR nurses in Norway have the same qualifications, and in case of lengthy procedures they switch roles to allow for food and toilet breaks, thus reducing the risk of fatigue.

6.1 | Strengths and limitations

The Delphi technique was an appropriate method of uncovering the non-technical skills of OR nurses. The online survey software SurveyXact proved suitable for creating, distributing and collecting surveys. Although the software is not customized for the Delphi technique, it facilitated feedback at personal and group levels in connection with the appropriate question. The electronic survey enabled the inclusion of panel members from a variety of locations. The participants answered the survey on their preferred device and were able to take breaks at their convenience (Whitehead & Day, 2016).

Survey round II was extensive, and some panel members had difficulties completing the survey due to coronavirus disease 2019 pandemic. A decision was made to accept all surveys with completed category-level questions, and missing re-ratings of elements was interpreted as 'no alterations needed'.

Despite aiming for neutral wording, it proved difficult to obtain nuanced ratings on element level. We suspect that this was caused by a Hawthorne effect (Polit & Beck, 2017).

We recognize a possible researcher bias because two of the authors are OR nurses. This bias may have influenced the analysis due to an understanding of the OR culture and the regulations under which the OR nurses perform.

7 | CONCLUSIONS

The novelty of this study is the identification of an array of previously unexplored non-technical skills essential for the performance of safe and efficient OR nursing. To our knowledge, this is the first empirical research aiming to uncover the non-technical skills of OR nurses including the relatively unexplored role of the circulating nurse. Previously, the role of the scrub nurse has been considered essential for teamwork in the OR, with less attention being paid to the role of the circulating OR nurse. Our findings showed that the non-technical skills of the circulating nurse are more complex and autonomous than those of the scrub nurse. Through our study, we have contributed to a verbalization of knowledge and skills previously considered tacit. This verbalization may facilitate teaching of such skills rather than relying on non-technical skills developing over time. We consider this the first step in bringing non-technical skills into 'the open', and we believe that this may contribute to OR nursing worldwide receiving the respect it deserves.

Further research on the non-technical competence of OR nurses, and integration of these skills into OR nursing education at an international level is needed. We also recommend further research on the non-technical skills of circulating nurses that would complement the existing findings about scrub nurses, because both roles are essential to ensure patient safety in the OR.

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CONFLICT OF INTEREST

No conflict of interest has been declared by the authors.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.

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