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# ABSTRACT

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NURSING INTENSITY AND NURSE STAFFING IN PERIOPERATIVE SETTINGS
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The goal of this study was to design and test a nursing intensity (NI) instrument in perioperative settings to produce information concerning patients' care needs. This information is intended to be used for knowledge-based management purposes when applying optimal nurse staffing.

In Phase I, a Delphi method with two rounds (n=55) was used to define the core elements of perioperative nursing. Then those core elements were tested to evaluate NI during the pre-, intra-, and postoperative phases of the surgical patient's care process (n=308 patients). In Phase II, the core elements were implemented in an instrument, and further testing was carried out in different perioperative settings (n=876 patients). In Phase III, an integrative review was conducted to find out how nurse staffing had been executed in perioperative settings.

According to the results, the core elements of perioperative nursing describing patient's safety or patient's physiological needs were seen as the most crucial. A principal component analysis revealed that a patient's care needs vary from the intraoperative to postoperative phases of perioperative nursing. Patients in a high ASA class more frequently had high intraoperative NI points, but patients in a low ASA class did not automatically have fewer intraoperative care needs. The length of stay in the post-anesthesia care unit (PACU) and the type of follow-up unit could be predicted with intraoperative NI. Scant evidence was found concerning nurse staffing in perioperative settings. The need to take into account patients' care needs showed up in some papers, but these were not expressed in an assessable form. Staffing models in relation to perioperative nursing-sensitive outcomes were not found.

This study offers an instrument for evaluating NI in perioperative settings. This information produced can be utilized for nurse staffing and nurse staff allocation purposes. More research is needed that focuses more on the detailed use of information based on NI. Its potential to serve as a knowledge-based management tool also needs clarifying in future studies.

Keywords: perioperative nursing, nursing intensity, instrument development, nurse staffing

# TIIVISTELMÄ

Satu Rauta
HOITOISUUS JA HENKILÖSTÖMITOITUS PERIOPERATIIVISESSA TOIMINTAYMPÄRISTÖSSÄ

Turun Yliopisto, Lääketieteellinen tiedekunta, Hoitotieteen laitos

Annales Universitatis Turkuensis, Turku, 2018

Tämän tutkimuksen tarkoituksena oli suunnitella ja testata perioperatiiviseen hoitotyöhön sopiva, potilaan hoitoisuutta arvioiva mittari, joka tuottaisi tietoa potilaan hoidon tarpeista. Tätä tietoa voidaan käyttää tiedolla johtamisen apuna, kun suunnitellaan optimaalista henkilöstömitoitusta perioperatiiviseen hoitotyöhön.

Ensiksi määriteltiin Delphi-menetelmällä (n=55) perioperatiivisen hoitotyön ydinkohdat. Tunnistetut ydinkohdat testattiin arvioimalla potilaiden hoitoisuutta perioperatiivisessa hoitotyössä ennen, aikana ja jälkeen toimenpiteen (n=308 potilasta). Toisessa vaiheessa, aiemmin tunnistetut ydinkohdat implementoitiin mittariin. Testausta jatkettiin erilaisissa perioperatiivisen hoitotyön toimintaympäristöissä (n=876 potilasta). Lopuksi tehtiin integratiivinen kirjallisuuskatsaus perioperatiivisten toimintaympäristöjen henkilöstömitoituksen selvittämiseksi.

Tulosten mukaan tärkeimpinä pidettiin potilaan turvallisuutta ja fysiologisia tarpeita kuvaavia ydinkohtia. Pääkomponenttianalyysin mukaan potilaiden hoidon tarpeet vaihtelivat hoidon eri vaiheissa ja ehdotetun mittarin sisältö oli erilainen intra- ja postoperatiivisesti. Vaikka korkea ASA-luokka olikin yhteydessä korkeaan intraoperatiiviseen hoitoisuuteen, matalan ASA-luokan potilaat eivät automaattisesti saaneet matalia intraoperatiivisia hoitoisuuspisteitä. Intraoperatiivisella hoitoisuudella pystyttiin ennustamaan heräämössä oloajan pituutta ja jatkohoitoyksikön tarvetta. Kirjallisuuskatsauksessa löytynyt näyttö koskien henkilöstömitoitusta perioperatiivisissä toimintaympäristöissä oli niukkaa. Tarve huomioida potilaiden hoitoisuutta tuotiin esiin, mutta sitä ei kuvattu tarkemmin. Henkilöstömitoitusalleja liittyen perioperatiivisiin hoitotyösensitiivisiin tuloksiin ei löytynyt.

Tutkimus tarjoaa mittarin hoitoisuuden arviointiin perioperatiivisessa hoitotyössä. Mittarin tuottamaa tietoa voidaan hyödyntää henkilöstömitoituksessa ja henkilöstöresurssien jakamisessa. Tarvitaan kuitenkin lisätutkimusta, jotta hoitoisuustiedon tuottama mahdollinen lisäarvo, ja sen käyttäminen tiedolla johtamisen apuvälineenä selkiytyisi.

Avainsanat: perioperatiivinen hoitotyö, hoitoisuus, mittarin kehittäminen, henkilöstömitoitus

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# ABBREVIATIONS

| | |
|---|---|
| ANA | American Nurses Association |
| ASA | Physical Status Classification System of the American Society of Anaesthesiologists |
| AORN | Association of periOperative Registered Nurses' |
| ASPAN | American Society of Perianesthesia Nurses |
| ASU | Ambulatory Surgery Unit |
| CVI | Content Validity Index |
| DRG | Diagnostic Related Group |
| FORNA | Finnish Operating Room Nurses Association = Suomen Leikkausosaston sairaanhoitajat ry. |
| ICU | Intensive Care Unit |
| LPN | Licensed Practical Nurse |
| NA | Nurse Assistant |
| NI | Nursing Intensity |
| NICE | National Institute for Health and Care Excellence |
| OR | Operating Room |
| OPC | Oulu Patient Classification |
| PACU | Post Anaesthesia Care Unit |
| PAONCIL | Professional Assessment of Optimal Nursing Care Intensity Level |
| PC | Principal Component |
| PCA | Principal Component Analysis |
| PCS | Patient Classification System |
| RN | Registered Nurse |
| SASH | The Finnish Association of Nurse Anesthetists = Suomen Anestesiasairaanhoitajat ry |
| SSI | Surgical Site Infection |
| SOI | Severity of Illness |
| TENK | Finnish Advisory Board on Research Integrity |

# LIST OF ORIGINAL PUBLICATIONS

I Rauta S, Salanterä S, Nivalainen J & Junttila K. 2013. Validation of the core elements of perioperative nursing. Journal of Clinical Nursing, 22, 1391–1399.

II Rauta S, Salanterä S, Vahlberg T & Junttila K. 2017. Testing an Instrument for Assessing Nursing Intensity in Perioperative Settings: Construct Validity. International Journal of Nursing Knowledge, 28 (4), 233–240.

III Rauta S, Salanterä S, Vahlberg T & Junttila K. 2017. The criterion validity, reliability and feasibility of an instrument for assessing nursing intensity in perioperative settings. Nursing Research and Practice. Volume 2017, Article ID 1048052, 9 pages https://doi.org/10.1155/2017/1048052

IV Rauta S, Salanterä S, Siirala E & Junttila K. 2018. An integrative review of nurse staffing in perioperative settings. Submitted.

# 1 INTRODUCTION

Nursing intensity (NI) indirectly describes the nurses’ contribution to patient care. It produces a unique point of view to the patients’ care describing their care needs. By combining the information gathered from patients’ care needs and the number of nurses involved and comparing this information for the optimal level of nursing intensity, it is possible to follow the nurses’ workload and keep it optimal. At the optimal level, the patients receive nursing care that is safe and of good quality.

Perioperative nursing is nursing care performed in operating departments, day surgery units, or post-anesthesia care units by qualified professionals. In Finland, approximately 365,000 surgical operations or procedures are performed in a year (Association of Finnish Local and Regional Authorities). In the care process of the surgical patient, the most expensive phase of care is the time the patient is in the operating department (Peltokorpi & Kujala 2006, Macario 2010, Butler et al. 2012). When considering nursing personnel in hospitals, it is a fact that operating departments are heavily staffed units with a large number of registered nurses (RNs). These staffing needs are due to the fact that usually at least three RNs are needed in a single operating suite. However, the surgical patient’s care involves multi-professional teams.

Surgical performance is accurately monitored. The number of procedures, turnover times, and utilization rates per suite describe the effectiveness of surgical performance on the organizational level. In addition, the quality of care concerning complications is followed. From the nursing staff, information about expenses, salaries, proportion of overtime, and sickness absenteeism is gathered for the purposes of human resource management. Currently, the need has arisen to address nursing-sensitive outcomes, that is, the value nurses have for the patients. In the Finnish perioperative nursing context, Lamberg et al. (2013) have studied the priority of nursing-sensitive outcomes. They are related to safety (freedom from acquired physical injury), physiological responses (physiological responses to surgery are as expected), behavioral responses comprising knowledge about the perioperative process, and behavioral responses comprising patient rights and ethics.

Perioperative nursing should be evidence-based to gain the desirable outcomes (Health Care Act 1326/2010). In line with this demand, nurse managers in perioperative settings should base their decisions on knowledge. Knowledge-based management involves a set of management actions or activities and ways or processes as gathering, storing, refining, transferring, and utilizing knowledge in an organization's internal and external communication. Knowledge that has been refined from information will produce more value to the organization and will meet its tactical and strategic requirements (Alavi & Leidner 2001, Frost 2012, Sitra 2014, Inkinen et al. 2015, Zablith et al. 2015, see also Wang et al. 2016). A need for encompassing, coordinated, and accessible information has been recognized as a prerequisite for knowledge-based management (Pinho 2011, Yun 2013, Lee 2014, Ravandi 2014, Sibbald et al. 2015). The information should be gathered from different sources, and it should be refined as knowledge that is usable for knowledge-based management purposes.

For perioperative settings, an instrument for assessing NI has not been available. However, the so-called RAFAELA® system, which includes an instrument for wards and outpatient clinics, has been studied a lot as a workforce planning tool for nurse staffing and human resource management (Frilund & Fagerström 2009, Andersen et al. 2014, Fagerström et al. 2014, Berger Hustad et al. 2015, Van Oostveen et al. 2015, Fagerström et al. 2018).

The goal of this study was to design and test an instrument for assessing NI in perioperative nursing. Using the information gathered with the instrument, it should be possible to make decisions concerning the need for nurse staffing and nurse staff allocation to match patients' care needs. This gives the possibility to challenge the traditional and conventional ways of calculating the number of nursing staff needed in perioperative settings. The ultimate goal was to support nurse managers' possibilities to articulate the needs concerning nurse staffing and nurse staff allocation.

The instrument was developed adapting a scale using a classic test theory first presented by Nunnally and Bernstein in 1994. The phases we followed were defining the concept, designing the scale, reviewing the items, conducting a preliminary item tryout, performing a field test, conducting item analyses, selecting items to retain, conducting validity studies, evaluating the reliability of the scale, and compiling the norms of the scale (Grove et al. 2013).

Finally, these results will be useful as a basis for more detailed implications of NI and its connection with other metrics produced from surgical performance for future research purposes.

# 2 BACKGROUND OF THE STUDY

This chapter will first present a definition and a description of perioperative nursing, and the perioperative nurse in section 2.1, followed by a description of perioperative settings in section 2.2. Concepts describing the amount of nurses' work, including nursing intensity is considered in section 2.3. And section 2.4 focuses on the assessment of nursing intensity.

## 2.1 Perioperative nursing / perioperative nurse

Perioperative nursing is a part of the nursing care of a surgical patient going through an operation or other invasive procedure. In this study, referring to Junttila (2005), a perioperative nurse means a registered nurse (RN) who works either in an operating department (including the day surgery unit) in the roles of an anesthetic, circulating, scrub, and/or post-anesthesia care nurse. This definition is broader than the definition of AORN (Association of periOperative Registered Nurses), which includes only the roles of the circulating and scrub nurse (http://www.aorn.org). In the United States, the term perianesthesia nurse is also used for a nurse practicing in the pre- and postanesthesia care phases (http://www.aspan.org/). The European Operating Room Nurses Association (EORNA) defines perioperative nursing "as nursing care delivered in the pre-, intra-, and postoperative phase of surgical patient care." EORNA (2017) also defines the professional perioperative nurse as an expert in one or more fields of perioperative nursing.

Nursing care in perioperative settings consists of planning, coordinating, delivering, and evaluating nursing care to patients who are vulnerable because their protective reflexes or ability to take care of themselves are weakened during the operation or other surgical procedure. Scientific research-based clinical knowledge and reasoning skills are needed to respond to patients' physical, psychological, and spiritual care needs and to deliver nursing care of good quality (AORN 2014).

In Finland, there are professional associations both for operating room nurses (Finnish Operating Room Nurses Association, Suomen Leikkausosaston sairaanhoitajat ry (http://www.forna.fi/), including circulating and scrub nurses) and for nurse anesthetists (Finnish Association of Nurse Anesthetists, Suomen Anestesiasairaanhoitajat ry (http://sash.fi/), including nurse anesthetists), from the preoperative to the postoperative phases of care.

In the Finnish curricula at universities of applied sciences, perioperative nursing is mainly described as including both operating room nursing and anesthesia nursing care. Perioperative nursing consists of nursing care in the pre-, intra-, and postoperative phases of surgical patient care. Preoperative nursing is performed immediately before surgery or a procedure and postoperative nursing immediately after. Intraoperative nursing care takes place in the operating suite. The term "peri" comes from Greek and means "around." So, perioperative nursing manifests "around an operation."

The terms "operating room nurse" and "operating theatre nurse" are used only for the roles of scrub nurses and circulating nurses (e.g., Riley & Manias 2009, Minnick et al. 2012, Zhou & Gong 2015) or scrub nurses, circulating nurses, and nurse anesthetists (e.g., Lindwall & Post 2008, Pulkkinen et al. 2015, Eskola et al. 2016).

Perioperative nursing requires advanced competencies and technical skills, including responsibilities for equipment and instrumentation related to surgical techniques. Specialized knowledge including technical expertise is essential but is not enough (Gillespie et al. 2008, Gillespie et al. 2009, Jeon et al. 2016). Perioperative nursing has been described through four points of view: 1) the patient's and his/her family's behavioral responses to an operation or surgical procedure, 2) safety, 3) physiologic responses to the operation or surgical procedure, and 4) the health care system delivering perioperative nursing care (Petersen 2007).

The patients' and family's behavioral responses to an operation or surgical procedure is comprised of information, coping, and emotional support. Patients and their family members need enough relevant information in perioperative settings (Junttila et al. 2005, Majasaari et al. 2005, Rhodes et al. 2006, Gilmartin & Wright 2008). The patients' need for ongoing psychological support in patient-centered care has been recognized (Gilmartin & Wright 2008). In addition, their family members need emotional support (Majasaari et al. 2005). Patient's stress and anxiety may decrease when a family member is present. Patients may also be more satisfied if they have their significant others near them (Rhodes et al. 2006). The presence of parents is especially important for children (Romino et al. 2005).

In perioperative nursing, the focus is on preventive practices to avoid complications and ensure patients' safety (Bull & FitzGerald 2006). Surgery breaks skin integrity, which is a risk factor for infection. Perioperative positioning may expose patients to the risk of physical or nerve injury. In addition, extraneous objectives, chemicals, electricity, transfers, and transport may cause harm to patients in perioperative settings (Petersen 2002). Documenting aseptic performance is one of the most commonly documented perioperative nursing interventions (Junttila et al. 2005).

Although patients' needs related to physiology are very important in perioperative nursing due to the anesthesia and surgery, not much research has been conducted in this area (Nivalainen et al. 2009). Risks of concern are changes in hemodynamics, in breathing or ventilation, and fluid and electrolyte balance during surgery (Petersen 2002). In perioperative nursing, the nursing documentation concentrates mainly on describing the patient's status related to physiological needs (like relieving pain), maintaining the patient's temperature, assessing and substituting fluid volume, and bleeding during the operation or surgical procedure (Junttila et al. 2005).

Unpleasant symptoms—such as nausea and vomiting, drowsiness, difficulty in breathing, and pain—are common in the postoperative phase of the surgical patient's care (Gilmartin & Wright 2008). Perioperatively, it is important to perform nursing interventions that warm up patients because inadvertent perioperative hypothermia is common among surgical patients in perioperative settings (e.g. Scott & Buckland 2006, Kiekkas et al. 2011, Knaepel 2012, Giuliano & Henricks 2017).

Perioperative nursing is nursing care in multiprofessional teams, where non-technical skills, like task management, communication and teamwork, situation awareness, and decision-making, are needed to complement clinical expertise (Yukes et al. 2008, Flin et al. 2011, Mitchell et al. 2011, Mitchell et al. 2013, Lyk-Jensen et al. 2014). These non-technical skills may affect an operation's duration or errors during procedures (Catchpole et al. 2008), and teamwork is associated with patient safety (Manser 2009). Besides, managing situations was emphasized when reviewing competence assessment instruments in perianesthesia nursing care (Jeon et al. 2016).

Finally, patients in perioperative settings are highly vulnerable due to the surgery and anesthesia, and they need nurses' advocacy (Munday et al. 2014) and a caring encounter with nurses to have individual and dignified nursing care (Pulkkinen et al. 2015). Lindwall & Post (2009) have presented perioperative nursing as a caring profession. They emphasized the continuity in the care process to generate a safe nursing environment. Despite focusing on technological activities in surgery and anesthesia, the ethics of care with an interaction between nurses and their patients remain. According to Bull & FitzGerald (2006), in perioperative nursing, technological proficiency and patient-focused ethics are joined together. Gillespie et al. (2012) have also identified empathy, proficiency, and professional development as perioperative nursing competencies.

Appropriate staff allocation has been identified as one of the core domains when discussing management and leadership skills in perioperative nursing (EORNA 2017). According to Siirala et al. (2016), perioperative nurse managers make two kinds of decisions concerning staff allocation. First, "immediate ad hoc" decisions concern staff allocation, which is based on nurses' competence and skills. Secondly, "in the near future" decisions comprises information from the patients' anamnesis and medical history. Perioperative nurse managers are responsible for optimal nurse staffing, which means an adequate number of nursing staff members for each operation or surgical procedure intraoperatively and pre- and postoperatively, ensuring adequate nurse-to-patient ratios in the PACU (Siirala et al. 2016).

## 2.2 Perioperative settings

Perioperative settings include both operating departments or operating rooms (ORs) and day surgery units or ambulatory surgery units (ASUs). These may represent different subspecialties of surgery—orthopedic surgery, ear, nose and throat surgery, eye surgery, obstetric-gynecological surgery, vascular surgery, urologic surgery, plastic surgery, pediatric surgery, heart-thoracic surgery, gastro surgery—and emergencies from these different subspecialties. In addition, post-anesthesia care units (PACUs) are incorporated in perioperative settings like the so-called holding areas, where patients are being prepared for surgery or a procedure by optimizing their condition.

In Finland, the nursing staff in perioperative settings may work in a concise area of a surgical subspecialty (eye surgery, for example) or environment (only in the PACU, for example) or in an extensive area in different perioperative roles—from the preoperative holding area to post-anesthesia nursing care. This is because surgical performance has been arranged in various ways throughout the country, varying from small elective units with a few operating suites to large multi-suite operating departments handling emergencies 24/7 in addition to some special national responsibilities.

In Finnish perioperative settings, mainly registered nurses (RNs) are involved, and there are no such professions as surgical technicians or first assistants. A few licensed nurses may work in some perioperative settings, performing duties in plastering or position-placing for surgery, for example. Auxiliary personnel are involved in performing ancillary services like cleaning and instrument maintenance.

## 2.3 Concepts describing the amount of nurses' work

In the literature, several concepts are used to illustrate the amount of nurses' work. The next paragraphs give an overview of the extent of concepts in this field.

Five main categories have been presented as a result of a concept analysis concerning nursing workload: 1) amount of nursing time, 2) level of nursing competency, 3) weight of direct patient care, 4) amount of physical exertion, and 5) complexity of care (Alghamdi 2016). According to Alghamdi (2016), the nursing workload consisted of the degree of time and care the nurse gives, not only to patients but also to the organization and professional development. Both direct and indirect nursing are considered. Direct nursing activities are those performed through interaction with the patient. Thus, indirect nursing activities are performed away from the patient, but on his or her behalf to support the direct nursing activities (see, for example, Wright 2013, Young et al. 2015). This definition of workload is broader than just the patient's care needs. Also Swiger et al. (2016) defined nursing workload as the degree of time combined with care, assuming that a nurse puts physical and/or cognitive effort into performing this care. All aspects of care are involved: direct patient care, indirect patient care, and non-patient care activities.

Alghamdi (2016) identified three kinds of nursing activities: direct nursing activities, indirect nursing activities, and non-nursing activities. Non-nursing activities include tasks for administrative and management purposes, different kinds of meetings and educational events for staff, and all activities that are not directly done for patients (Alghamdi 2016).

According to Swiger et al. (2016), nursing workload is a complex phenomenon. The nurse, patient, unit, and organizational characteristics are all involved. As a result, nursing care of high quality and enhanced patient outcomes might be possible or impossible. In the acute care setting in the hospital, some factors concerning the organization—the number of interruptions at work, the patient turnover rate, and the number of mandatory registrations—seem to have an impact on the workload (Myny et al. 2012).

Minnick et al. (2012) have studied the workload in perioperative settings. The nurses' experiences concerning the workload varied from those of surgeons and anesthesia providers. A nurse's workload was influenced by the surgeon's communication skills when informing nurses about their plans at the right time. Instead of using nurse-to-patient ratios when describing their workload, nurses considered it through the role of a scrub nurse or circulating nurse. The workload of a circulating nurse increased if therapeutics (such as medications and blood products) were missing or if equipment was broken or incomplete. In addition, schedule pressure and schedule changes (such as unscheduled cases and unplanned cases during a work shift) increased the workload (Minnick et al. 2012).

The workload is also influenced by patient dependency, severity of illness (SOI), complexity of care, and the level of nursing intensity (Alghamdi 2016). Care dependency has been revealed among patients after surgical procedures (Guangyan et al. 2017). It describes the patient's dependence on nursing care (e.g. Boggatz et al. 2007, Hurst 2008, Heslop & Plummer 2012). Care dependency can be defined as "a subjective, secondary need for support in nursing care to compensate for a self-care deficit." For care dependency, necessary antecedents are limitations in function. Possible consequences are those needs that are not fulfilled (Boggatz et al. 2007). From the patient's point of view, care dependency could be a positive stimulator because it may indicate a better alliance for treatment (Geurtzen et al. 2018).

SOI gives a medical classification based on physiologic decompensation of patients, considering diagnoses and procedures performed. Patients with high SOI are supposed to need more care and longer hospital stays than those with low SOI within the same Diagnostic Related Group (DRG) (Horn et al. 1984, Gertman & Lowenstein 1984). However, SOI does not necessarily correspond to the patient's need for nursing care (Carayon & Gürses 2004).

A concept analysis related to complexity of care by Guarinoni et al. (2014) revealed a variability in definitions of "complexity of care" currently found in the literature. According to their results, complexity of care is twofold. On the one hand, it can be quantified and classified. But on the other hand, it contains unmeasurable, subjective features. These qualitative aspects were verified in their subsequent research. Therefore, complexity of care can be defined through quantitative measurement of contextual elements as well as organizational variables aiming to improve the economics and management of the care process. However, the possibility of classifying complexity of care gives the potential to improve resource allocation. In relation to the concept of intensity, there is not always a clear distinction made in the literature (Guarinoni et al. 2014).

The term "acuity" is also used in the literature (e.g. Hoi et al. 2010, Kontio et al. 2014, Sir et al. 2015) to describe the phenomena, which is labeled "NI" in this study. In their concept analysis, Brennan and Daly (2009) organized an identified attribute's "severity," "intensity," and "the pairing of acuity measurements with another concept" as patient-, provider-, or system-related. Their proposal for a definition of patient acuity was "a measure of the severity of illness of the patient and the intensity of nursing care that patient requires." They concluded that there is a need for a clear specification of which attribute of acuity the researchers are interested in. In addition, they called for tools to measure these attributes. In line with this demand, our interest is NI—provider-related acuity.

There are two aspects describing nursing intensity (NI): direct and indirect nursing care activities. Non-nursing activities, which may include the work of nurses, are not involved (see Morris et al. 2007). The starting point of NI is wider than just a calculation of nurse-to-patient ratios (e.g. Welton et al. 2009, Needleman et al. 2011, Aiken et al. 2014) or calculating the time a nurse is involved in direct or indirect nursing care (Cusack et al. 2004). The focus is on the patient's care needs and the nurse's responses to those needs with appropriate nursing interventions. This definition was originally presented in the early 2000s as part of a development project concerning the RAFAELA® system in Finland (Fagerström et al. 2000, Rauhala & Fagerström 2004).

NI is valuable to know when calculating the number of nurses needed in a certain unit. It is not just the number of patients, but also these patients' needs for nursing care that has to be considered (Needleman et al. 2011).

To conclude, NI is one of the elements influencing the nursing workload. However, other elements are also involved when discussing the nursing workload, such as dependency, SOI, and complexity of care. The nursing workload is also influenced by organizational factors. Therefore, nursing workload describes a broader phenomenon than nursing intensity. In this study, NI is defined as the patients' need for nursing care and the nursing interventions performed to fulfill those needs. It describes how much care—including help, relief, and support—a patient requires in relation to what he/she receives. The goal is to ensure the safety and quality of performance in nursing care.  (See Fagerström et al. 2014, Andersen et al. 2016, Flo et al. 2016, Junttila et al. 2016.)

## 2.4 Assessment of nursing intensity

It seems that instead of assessing nursing intensity, it is more common to assess the nursing workload. According to Duffield et al. (2011), it is challenging to measure nursing performance because of its invisibility. However, it is essential to identify appropriate nurse staffing levels in order to succeed in providing nursing care that is safe and of high quality.

In their integrative review, Fasoli & Haddock (2011) reviewed 63 articles reporting studies related to Patient Classification Systems (PCS), Patient Acuity Systems, and Workload Management Systems from 1983 to 2010 designed for hospital patients in medical/surgical settings. They found that measuring nurses' workload was challenging, that definitions and descriptions of nurses' work were scarce, that evidence related to validity and reliability PCSs was inadequate, and that identifying nursing-sensitive outcomes and indicators were missing. Based on their review, Fasoli & Haddock (2011) discussed the lack of consensus on PCSs. They suggested that PCSs as a means to predict staffing should minimize additional workload based on expert nurses' judgment. They should honestly reflect nurses' work while measuring patient complexity. Attention should be paid to the nursing care needed, available human and other resources, and relevant organizational characteristics.

Hoi et al. (2010) have developed a workload intensity management system to measure staffing needs by using 28 nursing diagnoses as critical indicators of the nursing workload. These indicators were combined with the observed time nurses spent performing nursing interventions. For those 28 nursing interventions, a daily nursing time was recognized; and based on this time, a prediction model was designed. The model also took into account the nursing time for each patient in a ward and the time spent in indirect patient care. A prediction of nursing time needed could be made when considering the number and mix of patients. The aforementioned 28 nursing diagnoses explained 60–70% of the variation in nursing time. According to Hoi et al. (2010), patient dependency should be separate from acuity status when forecasting the workload because they do not correspond.

Oetelaar et al. (2017) present a study protocol where they aimed to develop a method for dividing the nurses' workload into equal parts in hospital wards. First, the nurses listed characteristics of their patients relevant to time of care. Then these characteristics were linked to the information gathered from time studies of nurses' activities. Finally, available nursing resources were meant to be compared to these metrics. This development was supposed to perform closely with the nurses and ward management. The method was intended to be usable for staff planning purposes and not just for retrospective analysis.

In perioperative settings, evaluation of nursing work has still been rare. Edel has published an article about a perioperative patient acuity system in 1995. Kusler-Jensen (1996) reported a patient classification system for ambulatory surgery centers. AORN has presented OR (operating room) Patient Classification for Staffing Assignments by combining the ASA Physical Status Classification (American Society of Anesthesiologists 2014) with the complexity of surgical procedure (Bell 2015). Halfpap (2016) developed a PACU acuity scoring grid. After testing it, she concluded that a grid could be used to identify patient acuity. This identification was based on assignments of acuity points to nursing interventions in five categories. According to these acuity points, a PACU class could be formulated and converted to the nurse-to-patient ratio presented by the American Society of PeriAnesthesia Nurses (ASPAN) in 2015.

Young and Hooper (2008) have suggested the use of the NASA-TLX to evaluate the workload among the health professions, especially among perianesthesia nurses, but they have not used it in practice. The NASA-TLX has been used in the aeronautical and transportation industries, in psychology, and in technology-related fields; and like these industries, health care professionals routinely make critical decisions under high pressure. According to Young and Hooper (2008), the NASA-TLX could serve as a tool for nursing workload.

In Finland, the RAFAELA® Nursing Intensity and Staffing system is widely used, and it is also used in some other Nordic countries (Andersen et al. 2014, Fagerström et al. 2014, Flo et al. 2016). There has been some recent interest in testing the system in other European countries (Van Oostveen et al. 2015).

RAFAELA® is a Patient Classification System (PCS) where each patient's care needs are systematically evaluated with a nursing intensity instrument. The most studied nursing intensity instrument in the RAFAELA® system is the OPCq (Oulu Patient Classification) instrument, which was originally designed for use in hospital wards. The other instrument involved in the RAFAELA® system is the PAONCIL (Professional Assessment of Optimal Nursing Care Intensity Level) instrument, which has been developed for determining the optimal NI level for every single unit (e.g. Fagerström 1999, Andersen et al. 2014, Fagerström et al. 2014). Besides these, actual nursing staff resources are documented.

There is strong evidence supporting the validity of the RAFAELA® system regarding studies over a twenty-year period (e.g. Kaustinen 1995, Fagerström & Bergbom Engberg 1998, Fagerström & Rainio 1999, Fagerström 2000, Rauhala 2008, Andersen et al. 2014, Fagerström et al. 2014, Flo et al. 2016). The OPCq instrument has been tested from different perspectives. The content validity has been proven to be relatively high (Kaustinen 1995, Fagerström 2000). The correspondence of the content validity with the experiences of the patients concerning their care needs has been studied, and it seemed that physical and psychological care needs are better expressed than those related to existential care needs (Fagerström & Rainio 1999). Furthermore, the associations between those care needs that patients have themselves expressed and those identified by their nurses have been compared, and the OPCq instrument has shown its potential to illustrate a wide range of patient's care needs (Fagerström & Bergbom Engberg 1998).

Parallel classifications were used to test the OPCq instrument's inter-rater reliability. This meant that two nurses independently used the instrument, and then both classifications were compared by the consensus percentage; 70% consensus was interpreted as sufficient (Kaustinen 1995, Fagerström & Rainio 1999). With the help of the PAONCIL instrument, the criterion validity of the OPCq instrument was studied so that the classifications made daily for each patient with the OPCq instrument were compared with the results of the PAONCIL instrument. This comparison indicated that the concurrent validity was fairly strong (Fagerström et al. 2000).

Further testing has been conducted by examining the correspondence of the PAONCIL instrument with traditional time studies. The results supported the relevance of the PAONCIL instrument (Fagerström et al. 2000, Rauhala & Fagerström 2004). As a part of the PAONCIL instrument, there is a list of non-patient factors (such as administration, the number of personnel, stress concerning work or life in general, and troublesome collaboration between the members of one's own unit or other units in the hospital) which were supposed to increase the total workload of nurses. Based on studies, it seems that these non-patient factors do not reduce the reliability of the PAONCIL instrument (Rauhala & Fagerström 2007, Fagerström & Vainikainen 2014).

The RAFAELA® system has also been tested in environments other than in hospital settings: in primary health care with older patients (Frilund & Fagerström 2009) and in home health care (Flo et al. 2016). However, before this study project, there has not been available a valid and reliable instrument for evaluating the surgical patient's care needs and thus nursing intensity in perioperative settings and by perioperative nurses. As a summary, in Figure 1 the background of this study is illustrated.

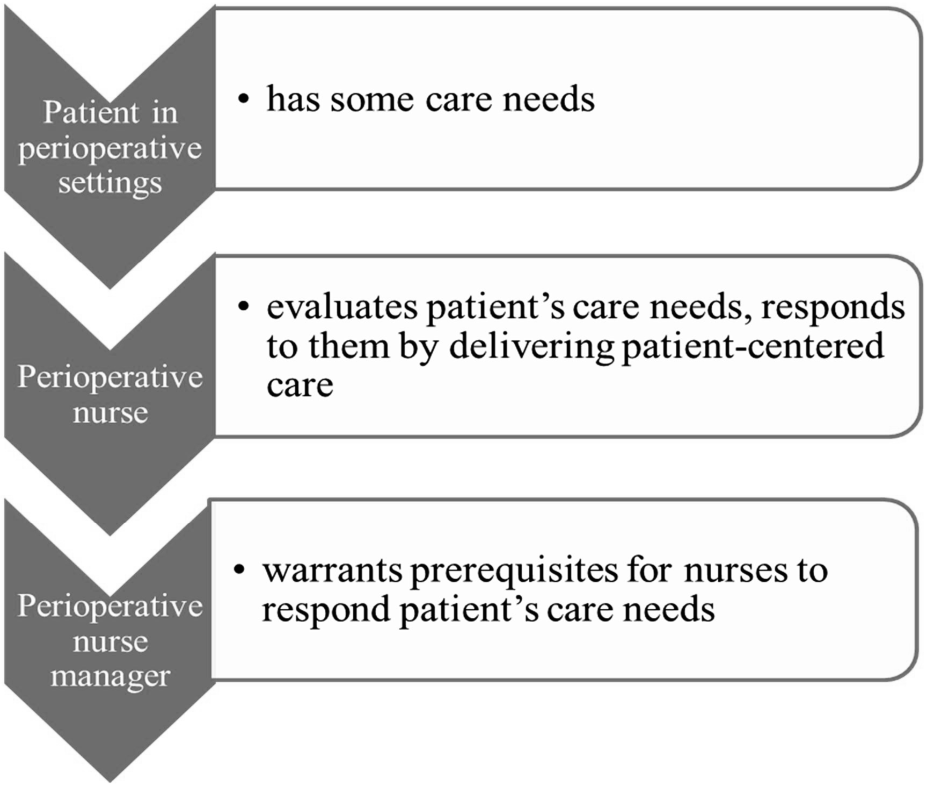


Figure 1. The background of the study

# 3 LITERATURE REVIEW

The first section of this chapter gives a description of nurse staffing in general. Section 3.2 presents an integrative literature review (years 2007–2017), which was also conducted to generate information concerning nurse staffing in perioperative settings. Summary of background of the study is presented in section 3.3.

## 3.1 Nurse staffing

Nurse staffing can be considered from three properties. First, as the number of vacancies (human recourses) on the unit level in general as part of long-term unit operation. Second, plans made for allocating staff is a part of the unit operation concerning the near future. And the third perspective considers it as on the dynamic, daily level as ensuring adequate staff for different tasks (Siirala et al. 2016).

The National Institute for Health and Care Excellence (NICE) (2014) gives recommendations for staffing extending from those registered nurses who are in charge of single wards or shifts to senior registered nurses with larger responsibilities. Registered nurses should be responsible for factors that are adequate for assessing optimal nursing staff requirements: patient-related factors such as patient acuity and patient dependency, ward factors and nursing staff factors (https://www.nice.org.uk/guidance/sg1/chapter/introduction#focus-of-the-guideline).

A lot of research demonstrates a link between inadequate nurse staffing and negative patient outcomes (e.g. Needleman et al. 2011, Junttila et al. 2016). In their literature review concerning studies made in intensive care units, McGahan et al. (2012) found that increased nurse staffing levels is associated with decreased adverse patient outcomes. Many inadvertent events, such as hospital-related mortality, hospital-acquired pneumonia, unplanned extubation, and cardiac arrest, failure to rescue, respiratory failure, and unplanned readmission to intensive care units or the operating theater occurs less frequently if the number of registered nurses were higher (Kane et al. 2008, Stone et al. 2008, Diya et al. 2012). In addition, pneumonia, urinary tract infections, pressure ulcers, falls, LOS, and the rates of postoperative infection decrease if the number of registered nurse hours involved increased (Pearson et al. 2006, Twigg et al. 2015).

On the contrary, many studies have identified associations between optimal nurse staffing and positive patient outcomes (Bray et al. 2010, Bledgen et al. 2011, Aiken et al. 2014, Cho et al. 2016). The allocation of qualified RNs with expertise and skills matched to patients' care needs enhanced safe nursing care with high quality (Needleman et al. 2011). Patient outcomes may depend on the composition of nurse staffing: the proportion of registered nurses (RNs), licensed practical nurses (LPNs), and nursing assistants (NAs) (e.g. Luke 2010).

From the nurses' point of view, adequate nurse staffing is essential to minimize nurses' job dissatisfaction and burnout (Aiken et al. 2002, Rafferty et al. 2007, Toh et al. 2012, Copanitsanou et al. 2017) and sickness absenteeism (Rauhala et al. 2007). Nurses' dissatisfaction and burnout at work in turn is linked to increased absenteeism. (Davey et al. 2009).

Many nurse staffing models have been developed, implemented, and used. Traditionally, nurse staffing has been expressed by calculating nurse-to-patient ratios (e.g. Rafferty et al. 2007, Aiken et al. 2014). However, the need to adapt nursing resources with patients' needs for nursing care, not just to the number of patients, has been recognized (Needleman et al. 2011).

The American Nurses Association (ANA) prefers flexible staffing models rather than fixed and rigid models (e.g. nurse-to-patient ratios) because they consider the complexity or acuity of care, the severity of patient condition, nursing expertise and skill level required, and the fluctuation in patient census. Flexible staffing models also take into account the environment and conditions where the care is provided: the physical space inside the unit and the available auxiliary personnel and resources. Besides, when determining optimal nurse staffing levels, number of admissions, discharges, and transfers have to be considered (ANA 2015).

The use of a flexible staffing model requires that all factors involved can be calculated in a reliable way (ANA 2015). Using validated tools when defining optimal staffing levels makes it possible to balance patients' care needs with the needed nurse staffing. Counting the costs from nursing resources is also of value (Keog 2013, Andersen et al. 2016). Optimal nurse staffing is essential in delivering nursing care of high quality and safety cost-effectively. According to ANA (2015), the focus on value-based care will increase in the near future. The care left undone, evaluated by nurses themselves, may offer a checkpoint warning about understaffing because optimal staffing levels can be considered by estimating the omission of needed nursing care. (Ball et al. 2014, Ball et al. 2016).

In the context of Finnish health care, we refer to earlier research where nurse staffing is determined to deliver quantitatively and qualitatively appropriate nursing care by personnel having sufficient knowledge and skills to produce these services. These services are given to the maximum number of patients in a way that is cost-effective, human, and efficient and leads to desirable patient outcomes and the personnel's job satisfaction (Partanen 2002, Tervo-Heikkinen 2008, Pitkäaho 2011).

## 3.2 Nurse staffing in perioperative settings

There is not much research on the effects of nurse staffing on patient outcomes in perioperative settings. Ensuring patient safety and quality of care also challenges us to strive for determining and evaluating nursing outcomes in perioperative settings. According to Alfedsdottir & Bjornsdottir (2008), the main threat to patient safety was an imbalance in staffing. Garret (2008) concluded in her review that low levels of nurse staffing might expose medical errors and adverse outcomes.

The association between OR staffing and patient outcome has been studied by Talsma et al. (2013). In contrast to studies demonstrating that additional nursing staff leads to lower rates of complications, this study shows that in perioperative settings, it is the opposite. A large number of postoperative complications occurred if a large nursing staff was involved in an operation or surgical procedure. The increased number of surgical site infections (SSIs) was especially associated with a larger nursing staff. These opposite results may be because chosen outcomes, including SSIs and a large number of postoperative complications concerning the medical condition, did not describe nursing-sensitive outcomes from the perspective of perioperative nursing. The other reason for these contradictory results may be explained by some confounding variable that has not been controlled (Talsma et al. 2013).

The contribution of perioperative nursing to the surgical patient's care process is challenging to determine and evaluate. An integrative literature review (years 2007–2017) was conducted to generate information concerning the nurse staffing in perioperative settings. The aim was to determine the extent and type of evidence available concerning nurse staffing or staffing models in perioperative settings. (See Paper IV for more detail.)

## 3.3 Summary of background of the study

The evidence of associations between nurse-to-patient ratios illustrating indicators of nursing workload with improved patient safety and quality of nursing care is constantly increasing in nursing environments other than perioperative settings (Aiken et al. 2014). According to Bray et al. (2010), it is challenging to verify the impact of nursing care on patient's outcomes. Despite that, they highlighted the nurses' contribution to produce adequate outcome indications and the data for these nursing-sensitive outcome measurements. However, one should bear in mind that nursing care is performed in a multi-professional environment and other professions are involved.

The contribution of perioperative nursing to surgical patient's care seems to be difficult to assess. Nurse staffing ratios used in other environments may not be applicable in perioperative settings (Talsma et al. 2013). Research tailored for perioperative nursing is scant. The connections between adequate nurse staffing levels and patients' outcomes need to be proven also in perioperative settings. Nursing intensity has mostly been studied indirectly via the nursing workload.

# 4 AIM OF THE STUDY AND RESEARCH QUESTIONS

The aim of this study was to design and test an instrument for assessing NI in perioperative settings. First, we aimed to identify the core elements of perioperative nursing and implement them with an instrument. Then we aimed to test the validity and reliability of the designed instrument in various perioperative environments. Lastly, we aimed to determine the basis for nurse staffing in perioperative settings.

The ultimate goal was to provide a valid and reliable instrument for evaluating nursing intensity. With the instrument tested in this study, it would be possible to produce information for knowledge-based management of adequate nurse staffing in perioperative settings.

The research questions were:

1) What are the core elements of perioperative nursing? (PAPER I, PHASE I / 1)
    - Validation of the description of the content of perioperative nursing based on earlier research and clinical expertise of the national group of nurses
    - Ensuring the content validity of the instrument
2) What would be the preferable structure of the instrument? (PAPER II, / PHASE I / 2)
    - Testing the construct validity of the instrument
3) How does the instrument work in different perioperative settings? (PAPER III, PHASE II)
    - Comparing NI to the ASA Physical Status Classification System
    - Testing the predictive validity of the instrument
    - Testing the reliability of the instrument
    - Evaluating the feasibility of the instrument
4) How is nurse staffing performed in perioperative settings according to the literature? (PAPER IV, PHASE III)
    - Reviewing nurse staffing practices in the operating department

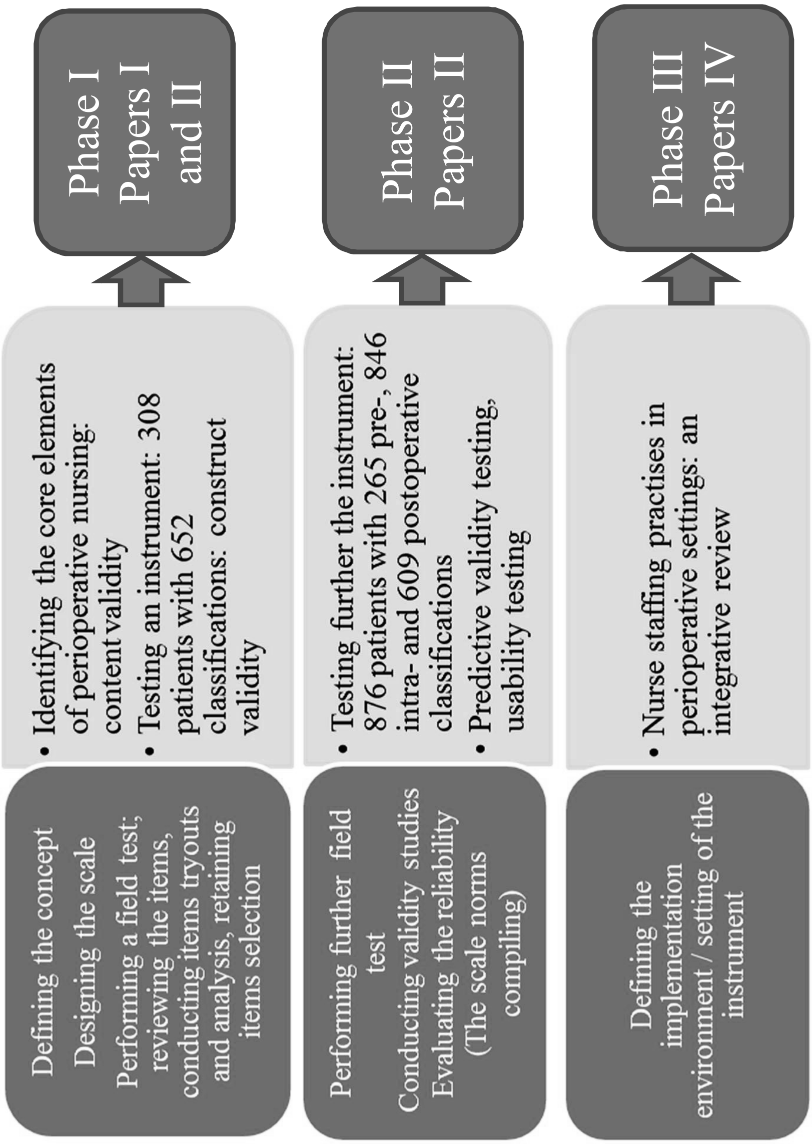


Figure 2. The study design adopting scale development theory

# 5 MATERIALS AND METHODS

This study adopted the instrument development steps presented by Grove, Burns, and Gray (2013). We began by defining the concept and proceeded with designing the scale. Then we performed a field test: reviewing the items, conducting item tryouts and analysis, and retaining items in our instrument.

A further field test was performed with validity studies and evaluating reliability. Finally, we shed light on the environment in which our instrument is intended to be used. Table 1 presents a summary of the materials and methods in each phase.

Table 1. The materials and methods of the study

| **Phases of the study** | **Settings and participants** | **Data collection** | **Sample (N)** | **Analysis** |
|---|---|---|---|---|
| Phase I/I (paper I) Content validity | 55 invited experts | suggested core elements evaluation in 2-round Delphi-panel | 1. Delphi round N=49<br>2. Delphi round N=27 | CVI * |
| Phase I/II (paper II) Construct validity | 3 ORs in a university hospital | NI evaluation using previously identified core elements | preoperatively N=138<br>intraoperatively N=282<br>postoperatively N=232 | PCA** |
| Phase II (paper III) Further testing in different perioperative environments | 9 ORs in 5 university hospitals | NI instrument | preoperatively N=265<br>intraoperatively N=846<br>postoperatively N=609 | Statistical tests; Kruskall-Wallis & Mann-Whitney U-test |
| Phase II (paper III) Predictive validity | 9 ORs in 5 university hospitals | NI instrument | preoperatively N=265<br>intraoperatively N=846<br>postoperatively N=609 | Statistical tests; Kruskall-Wallis & Mann-Whitney U-test |
| Phase II (paper III) Reliability | 9 ORs in 5 university hospitals | parallel classifications with NI instrument | N=144 | Agreement percentage |
| Phase II (paper III) Feasibility | 130 perioperative nurses | survey with electronic questionnaire | N=40 | Descriptive statistics CVI |
| Phase III (paper IV) | integrative literature review | Ovid Medline database search | 9 papers | Content analysis |

*CVI=Content Validity Index

**PCA=Principal Component Analysis

## 5.1 Study settings and participants

In the beginning of this study (PAPER I, PHASE I / 1), the suggested core elements were evaluated in the Delphi panel. Originally, a national workgroup representing extensive clinical and managerial competence and expertise in perioperative nursing recommended those core elements. Despite their proficiency, the literature was also taken into account.

The participants for the Delphi panel were suggested by the national workgroup members. They have nationwide connections in perioperative nursing. A purposive sampling was conducted to capture broad nationwide competence and expertise in perioperative nursing comprising educational levels and professional roles relevant to the field of perioperative nursing. Expertise in clinical practice, management, education, and research were appreciated.

After the selection process, altogether 55 experts participated in the Delphi panel: six participating in the pilot study and Delphi round I and an additional 49 panelists participating in Delphi rounds I and II.

The data for construct validity testing (PAPER II, / PHASE I / 2) were collected from three operating departments at one university hospital during a two-week period. These included operating departments representing different perioperative environments: outpatient surgery, elective surgery, and emergency surgery. All these departments also had a post-anesthesia care unit (PACU) and performed some preoperative activities such as preparing patients for surgery. The nurses who worked in those three departments as an anesthetic, circulating, scrub, and/or post-anesthesia care nurse and who had attended the training sessions arranged by the researcher were supposed to participate.

In the next phase, further testing with the instrument (PAPER III, PHASE II) was done in all of Finland's five university hospitals. Altogether nine operating departments were recruited, representing a wide range of surgical patients: pediatric and adult patients undergoing ear, nose and throat surgery, eye surgery, gynecologic surgery, urologic surgery, plastic surgery, endoprothesis surgery, and heart surgery including day surgery, short-stay surgery, and emergency surgery.

Altogether 130 perioperative nurses attend the study—anesthetic, circulating, scrub, and post-anesthesia care nurses. The nurses were recruited with the help of their managers. Before the data collection period, nurses were trained to use the instrument. The training sessions were scheduled to last two days. The content of the training comprised first the introduction of the instrument and the principles of how to use it (altogether four hours). Then the participants evaluated a variety of patient cases from their own operating departments. This was how they learned and practiced using the instrument. These training sessions with real patient cases lasted 3 hours per case for a total of 9 hours.

Finally (PAPER IV, PHASE III), the last phase included an integrative review of nurse staffing and nurse staff allocation in perioperative settings. Nine papers were reviewed.

## 5.2 Data collection and analysis

Two Delphi panel rounds (PAPER I, / PHASE I / 1) were electronically conducted to collect the data. Before the first round, a pilot test by six panelists was performed, and then the electronic questionnaire with some demographic background questions was sent to the selected panelists. The panelists were asked to rate each suggested core element on a scale of four: 4 = very relevant, 3 = fairly relevant, 2 = fairly irrelevant, and 1 = not relevant. The data that was gathered in pilot testing was included in the data of the first Delphi round. Between Delphi rounds I and II, some modifications were made to the suggested core elements. In the first Delphi round, the response rate was 89% (n=49), and in the second Delphi round it was 49% (n=27).

Two kinds of Content Validity Index (CVI) were calculated. First, the I-CVI (default value 0–1) was calculated for each suggested core element of perioperative nursing. The number of 3 and 4 ratings were added together, and the sum was divided by the number of respondents, as Lynn suggested in 1986. Polit et al. (2007) have pointed out that an I-CVI value of at least 0.78 indicates sufficient content validity. Furthermore, the scale-level CVI (S-CVI/Ave) was calculated by summing the I-CVI values and dividing the sum by the number of suggested core elements, as Polit & Beck (2006) suggested. Waltz et al. (2005) suggested that the value of S-CVI/Ave should be at least 0.90.

After Delphi round II, a consensus was obtained. During both Delphi rounds, the participants were encouraged to articulate potential core elements of perioperative nursing that might be missing from the workgroup’s suggestions. No suggestions for core elements emerged.

In the next phase (PAPER II, / PHASE I / 2), data collection was performed by using a formulated form, whereas in the previous phase (PAPER I, PHASE 1/1), the 24 identified core elements of perioperative nursing were presented. As part of their daily practice while caring for their patients, nurses rated the patients on these core elements of perioperative nursing.

The ratings were on a 4-point scale, where 4 meant the most demanding nursing care delivery, illustrating high nursing intensity; and 1 meant the slightest nursing care delivery, illustrating low nursing intensity. The evaluations were based on the nurses' clinical expertise and judgment. Every patient was rated once in each phase of the perioperative continuum: the pre-, intra-, and postoperative, depending on which phases were relevant and actualized. The rating was not expected if the patient was less than half an hour in the operation room. There were no other exclusion criteria. The total number of ratings was 652, of which 138 were made in the preoperative phase of a patient's care, 282 in the intraoperative phase, and 232 in the postoperative phase.

The data were analyzed with the IBM SPSS Statistics v. 19.0 software package. Descriptive statistics—frequencies and percentages—were calculated for background factors. The data were not normally distributed; thus a principal component analysis (PCA) was used instead of a factor analysis (FA) for exploring the structure of the instrument. The principal components correlated with each other, so an oblique rotation with Kaiser normalization was chosen. Eigenvalues greater than one were considered acceptable when determining the number of principal components (Bryman & Cramer 2001). Loadings greater than 0.3 were considered statistically significant. The communalities of each item were calculated (Child 2006).

In the next phase (PAPER III, PHASE II), data were collected for 1–2 months in each attending operating department. The data collection was initiated immediately after the training sessions. The nurses gathered the data by evaluating each patient they cared for, either in the pre-, intra-, or postoperative phase of the surgical patient's care process. The instrument tested had six main categories with 3–5 subcategories that described the core elements of perioperative nursing. The main categories were: 1) Planning and organization of the perioperative care, 2) Physiological balance, 3) Medication, pain, and nausea, 4) Aseptic practice, 5) Activity/rest, mobilization, and positioning, and 6) Support, guidance, and continuity of care, including specimens and examinations. The national workgroup that initially suggested the first phase of evaluating core elements and made a unanimous decision to continue testing with the aforementioned instrument instead of the instrument suggested by PCA in the previous phase. The core elements were organized based on clinical relevance in the main categories.

The data collection was concerned with a part of the daily nursing performance and was done by the nurse or team of nurses involved in patient care. The rating scale was the same as in the previous study phase—a 4-point scale—where 4 meant the most demanding nursing care delivery, illustrating high nursing intensity, whereas 1 meant the slightest nursing care delivery, illustrating low nursing intensity. Total NI points per patient were calculated by summing the NI points in the six categories. The points could range from 6 to 24. For reliability testing, five NI classes were included (Frilund & Fagerström 2009, Andersen et al. 2014, van Oostveen et al. 2015). Altogether, 876 patients were involved: 265 in the preoperative, 846 in the intraoperative, and 609 in the postoperative phase of care.

To test inter-rater reliability, two nurses separately and independently evaluated the same patient (N=144). This data were gathered during the test period from each attending operating department.

After the test period, a self-tailored electronic questionnaire was sent to the nurses (N=130). They were asked to answer on a four-point scale how well the instrument evaluated their patients' NI (1 = not well at all, 2 = not very well, 3 = quite well, 4 = very well) and how well the instrument could cover patients' care needs and also separate these care needs from each other. The respondents also rated the concreteness, usability, understandability, clarity, and objectivity of the instrument. The response rate was 31% (n=40).

SAS System for Windows, version 9.4 (SAS Institute Inc., Cary, NC, USA), was used for statistical analyses. Descriptive statistics—frequencies and percentages—were calculated. With Spearman correlation coefficients, the correlations between the total NI points and the ASA categories were examined. The Kruskall-Wallis test was used to examine the differences in NI points between ASA categories in pre-, intra-, and postoperative phases. Additional pairwise comparisons were performed with the Mann-Whitney U-test using Bonferroni corrected p-values. P-values less than 0.05 were considered statistically significant.

The predictive validity between NI points and PACU time was tested using Spearman correlation coefficients. The differences between NI points and the discharge unit from the PACU were tested with the Kruskall-Wallis test, and pairwise comparisons with the Bonferroni-corrected Mann-Whitney U-test. P-values less than 0.05 were considered statistically significant.

The agreement percentage between two nurses who independently performed classifications on the same patient (n=144) was used to test inter-rater reliability. Five NI classes were formulated based on singular NI points from both classifications, and these classes were compared to each other. The limit values for the classes were 6–8, 9–12, 13–15, 16–20, and 21–24 points. The agreement percentage was calculated, and over 70% has previously been accepted as satisfactory (Frilund & Fagerström 2009, Andersen et al. 2014, van Oostveen et al. 2015).

The data from the user survey were analyzed by calculating percentages when appropriate. CVI values (default 0–1) were calculated for the qualities of the instrument (Polit & Beck 2006). The total number of 3 and 4 ratings was divided by the number of nurses who responded to the survey (Lynn 1986). CVI values of at least 0.78 were interpreted as good content validity (Polit et al. 2007).

Finally, in the integrative review (PAPER IV, PHASE III), the literature search was made from the Ovid Medline database using the following search terms: operating room (including rooms operating, room operating, operating rooms, operating theatre, surgical theaters, and theaters surgical), resource allocation, staff allocation (including staff, personnel, human resources, manpower, allocation, and allocations). The restriction was made in the year of 2007 or later and no language or study design restrictions were applied.

A manual search from reference lists of potential literature was also carried out. The conference proceedings and the websites of important and well-known operators in the sphere of perioperative nursing were also looked at. This was expected to find evidence on a wide scope concerning nursing staff allocation in perioperative settings.

First, two researchers independently screened the titles and abstracts of each study. The options were “relevant” or “not relevant” or “unclear” using inclusion and exclusion criteria. The studies were included if they reported primary research (quantitative or qualitative) or were position statements or practice recommendations of well-known perioperative nursing organizations. The papers describing editorials and comments for some other papers were excluded. Also excluded were papers that did not mention nurses or the number of nursing personnel. Discrepancies were resolved by consensus.

The same researchers also independently reviewed the full texts of relevant papers. After that, the selection of final articles was made, and the data collection instrument presented by Sousa et al. 2010 (originally validated by Ursi, 2005) was used to represent data. Altogether, nine papers were included for the final analysis. Among these were a Position Statement and a Practice Recommendation.

Although no language restrictions were first applied, we had to reject two articles that were not available in full-text format and were written in German.

Data analysis was completed using content analysis. The data was extracted, categorized, and finally summarized in the findings. Extracted data included authors, publication, year of publication, country of publication, setting, research design, sample size, description of the methods used to allocate staff, objectives, outcomes measured, and authors’ conclusions.

Categorizing and summarizing the data were carried out descriptively. First, different aspects of the papers were recognized, and then emerged themes were grouped together to portray a logical body of knowledge on the topic.

## 5.3 Ethical questions

In every phase of the study, guidelines by the Finnish Advisory Board on Research Integrity—"The responsible conduct of research"—were followed (TENK 2012-2014).

Firstly (PHASE I / 1), the participation on the Delphi panel was voluntary. Written information concerning the study was given to the participants. They were also informed that it would be possible at any time to withdraw from the panel. If they returned the questionnaire, it was considered as their informed consent. The panelists did not know each other's identity. The data were analyzed with confidence. No single participant could be recognized because the analysis was anonymously made.

Finnish national legislation and ethical principles were considered when conducting this thesis. All studies (PHASE I / 2, PHASE II) had a research permit from the organizations involved according to their permit processes. Approvals from the ethics committee were not obtained because the patients' integrity and privacy were not touched, and no information was collected about the identities of the patients or the nurses. Ethical concerns were evaluated for admitting the permit for each study.

The information about the study was given to the nurses involved in data collection, both orally and in writing. Voluntary participation and the right to refuse or withdraw from the study were explained to them. Their informed consent was considered to be received when they returned the data collection forms.

The patients were not intentionally enrolled in the study, as their NI was evaluated as part of normal daily practice. There was no discomfort or harm caused. If the patient was inside the operating room no more than 30 minutes, an evaluation of NI was not expected. This limitation was made to ensure the patients' safety during the data collection period.

The data collection forms were anonymous. The data were handled with confidentiality. No names or identity codes were collected from the patients or nurses at any time. The names of the attending nurses were collected only to send the electronic survey to them afterwards. In their answers, no names were displayed, so their anonymity was ensured.

# 6 RESULTS

The results are presented along the order of instrument development: defining the concept, designing the scale, performing a field test with reviewing items, item tryouts and analysis, and items retained in our instrument.

A further field test is described with validity studies and an evaluation of the reliability. In the end, nurse staffing practices are presented based on an integrative literature review on perioperative settings.

## 6.1 The core elements of perioperative nursing

When identifying the core elements of perioperative nursing, the first round of Delphi panel accepted those core elements of perioperative nursing that were suggested by the national workgroup. After the first Delphi round, 14 of the suggested 24 core elements (58%) received a CVI value of 1.0. The rest of the core elements (10, 42%) were rated with CVI values varying from 0.84 to 0.98. S-CVI was 0.97 after the first Delphi round. Next, the core elements are named as they are named and presented in PAPER I.

The following changes were made after the first Delphi round based on the panelists' suggestions. The core elements related to medication (3) were considered to be confusing, so they were customized. Secondly, "Nausea" was added to the list of core elements. Thirdly, the core elements describing aseptic aspects (3) were modified.

After modifying the core elements, the second Delphi round was conducted. After that, 11 of the 24 core elements (46%) received a CVI value of 1.0. The CVI values of the rest of the core elements (13, 54%) varied from 0.85 to 0.96. S-CVI was 0.96 after the second Delphi round.

After the second Delphi round, CVI values related to the core elements referring to "Patient and family behavioral responses to surgery" went down. The CVI values of the core elements referring to "Safety" or "Physiologic responses to surgery" remained quite the same in both Delphi rounds (see Petersen 2007). Table 2 presents the core elements and their CVI values for both Delphi rounds.

Table 2. The core elements and their CVI-values in Delphi rounds I and II modified from Original Publication I

| **Core elements of perioperative nursing** | **CVI-values Delphi 1 (n=49) / Delphi 2 (n=27)** |
|---|---|
| **Patient and family behavioural responses to surgery** | |
| Pain | 1.00 / 1.00 |
| Patients' need of information | 1.00 / 0.89 |
| Patients' coping mechanisms and mental wellbeing | 0.98 / 0.89 |
| Patients' need of communication with significant others | 0.90 / 0.85 |
| **Safety** | |
| Arranging the patient care | 1.00 / 1.00 |
| Managing specimen collection and handling, ordering examinations | 1.00 / 1.00 |
| Creating aseptic circumstances | 1.00 / * |
| Monitoring and administering care to the surgical site | 1.00 / * |
| Perioperative positioning of the patient | 1.00 / 0.96 |
| Administrating anaesthetic medication | 1.00 / - |
| Administrating systemic medication | * / 1.00 |
| Administrating medication | 1.00 / * |
| Administrating local medication | 0.98 / 0.96 |
| Assessing medical history of the patient | 0.98 / 1.00 |
| Reporting and documenting the care | 0.98 / 1.00 |
| Creating the sterile field | * / 0.96 |
| Breaking down the sterile field and postoperative monitoring of the surgical site | * / 0.96 |
| Ensuring continuity of care | 0.92 / 0.93 |
| Administrating basic care re hygiene | 0.90 / 0.85 |
| **Physiologic responses to surgery** | |
| Nausea | * / 1.00 |
| Physiologic responses re circulation | 1.00 / 1.00 |
| Physiologic responses re fluid balance | 1.00 / 1.00 |
| Physiologic responses re respiration | 1.00 / 1.00 |
| Physiologic responses re body temperature | 1.00 / 1.00 |
| Physiologic responses re activity and/or rest | 0.92 / 0.92 |
| Physiologic responses re nutrition | 0.84 / 0.92 |

## 6.2 The validity and reliability of the instrument

First (PAPER II, / PHASE I / 2), the construct validity of the instrument was tested in the pre-, intra-, and postoperative phases of perioperative nursing care. In the preoperative phase, there were so many missing values that PCA was not possible. Therefore, any results from this phase do not exist. In the intraoperative and postoperative phases, there were 169 and 146 classifications, respectively. PCA was performed, and as a result four principal components were identified. Those four principal components received eigenvalues greater than 1. Next, the core elements are named as they are named and presented in PAPER II.

Intraoperatively, the identified principal components were labeled as "Safety," "Physiology," "Continuity," and "Specimens," and their received eigenvalues varied from 9.44 to 1.17. This model of four principal components explained 65.2% of the variance.

For the first principal component, ten items (core elements) were loaded. The range of the loadings was from 0.38 to 0.97. For the second principal component, five items (core elements) were loaded with a range from 0.42 to 0.90. Six items (core elements), with loadings from 0.43 to 0.83, were loaded under the third principal component. Only one item (core element) was loaded under the fourth principal component with a loading of 0.57. Clinically, this item (core element) was relevant, so it was accepted. Incoherently, this item (core element) was also loaded under the first and third principal components. The loadings of the items (core elements) are presented in Table 3.

Postoperatively, the components were labeled "Physiology," "Coping," "Wellbeing," and "Continuity." The range of eigenvalues of these principal components was from 7.16 to 0.95, and this model of four principal components explained 60.4% of the variance.

For the first principal component, nine items (core elements) were loaded. The loadings varied from 0.44 to 0.82. For the other three principal components, three items (core elements) were loaded for each. The range of the loadings were from 0.46 to 0.87 for the second principal component, from -0.35 to 0.80 for the third principal component, and from -0.35 to 0.80 for the fourth principal component. See more detailed loadings for principal components in the postoperative phase in **bold** in Table 3. In Table 3, the results from the intraoperative and postoperative phases of care have been combined into one matrix, so when interpreting, it has to be noticed that the components are named differently in the intraoperative and postoperative phases. Originally, these tables were presented separately in Paper II, on pages 237 (Table 2) and 238 (Table 3). From the final PCA, we excluded from both the intraoperative and postoperative phases two items: one concerning patient's and family member's communication, and the other related to nutrition. In addition, from the postoperative phase, items describing local medication (1) and aseptic performance (3) were excluded because of multiple missing values or the slight correlation with other variables. Thus, the number of remaining items was 22 and 18, respectively.

Table 3. The loadings of the items in intraoperative (n=169) / **postoperative phase** (n=146) modified from Original Publication II Table 2 and Table 3

| **Items** | **Principal Component 1** | **Principal Component 2** | **Principal Component 3** | **Principal Component 4** | **Communalities** |
|---|---|---|---|---|---|
| Arranging (managing) the patient care | 0.68 | | | **-0.87** | 0.72 /**0.78** |
| Assessing medical history of the patient | 0,72 | | | 0.37/**-0.87** | 0.80/**0.73** |
| Physiologic responses re body temperature | 0.57 | **0.55** | 0.55 | -0.33 | 0.62/**0.61** |
| Physiologic responses re circulation | 0.48/**0.59** | | 0.42 | | 0.63/**0.53** |
| Physiologic responses re fluid balance (fluid therapy) | 0.62 / **0.74** | | 0.40 | | 0.75/**0.76** |
| Breaking down the sterile field and postoperative monitoring of the surgical site | 0.97 | | | | 0.78 |
| Creating aseptic circum-stances | 0.91 | | | | 0.76 |
| Creating the sterile field | 0.80 | | | | 0.74 |
| Administrating systemic medication (drug therapy) | 0.52/**0.70** | | | | 0.68/**0.62** |
| Administrating local medi-cation | 0.38 | | | | 0.53 |
| Physiologic responses re respiration | **0.58** | 0.85 | **-0.35** | | 0.82/**0.53** |
| Physiologic responses re activity and/or rest | **0.57** | 0.45 | | -0.37 | 0.59/**0.51** |
| Pain | **0.76** | 0.42 | | 0.36 | 0.47/**0.52** |
| Level of consciousness | | 0.90/**0.46** | | | 0.72/**0.48** |
| Perioperative positioning of the patient | **0.72** | 0.65 | | | 0.69/**0.65** |
| Reporting and documenting the care | 0.53/**0.56** | | 0.43 | | 0.67/**0.66** |
| Ensuring continuity of care | | | 0.62 | **-0.59** | 0.58/**0.46** |
| Patients' coping mecha-nisms and mental wellbeing | | **0.87** | 0.60 | -0.39 | 0.57/**0.74** |
| Patients' need of infor-mation | | **0.86** | 0.83 | | 0.65/**0.74** |
| Administrating basic care re hygiene | 0.30/**0.44** | | 0.46 | | 0.42/**0.34** |
| Nausea | | | 0.55/**0.80** | | 0.32/**0.67** |
| Managing specimen collec-tion and handling, ordering examinations | 0.52/**0.82** | | 0.40 | 0.57 | 0.79/**0.56** |

Excluded from the PCA were the intraoperative phase items “Communication with significant others” and “Physiologic responses re nutrition” and the postoperative phase items “Communication with significant others,” “Administrating local medication,” and “Physiologic responses re nutrition,” “Creating the sterile field,” “Creating aseptic circumstances,” and “Breaking down the sterile field and postoperative monitoring of the surgical site.”

For the next phase of validity testing (PAPER III / PHASE II), we modified the instrument and continued the testing process with the instrument consisting of six main categories. This was partly due to the more precise clinical relevance of the six-category instrument. On the other hand, this was because other instruments in the RAFAELA® system include six categories; so this would allow the benchmarking activities at the hospital level. This decision is argued in more detail on page 35.

Altogether 846 patients were classified in the intraoperative phase of perioperative nursing, 609 patients in the postoperative phase, and 265 patients in the preoperative phase.

The highest median NI point value of 10 was in the intraoperative phase, and the lowest median NI point value of 7 was in the preoperative phase. In the postoperative phase, the median NI point value was 8. The minimum NI points were 6 in all three phases, but the maximum NI points (24) was only for patients in the intraoperative phase. In the postoperative and preoperative phases, the maximum NI points were 20 and 16, respectively.

A moderate positive correlation was found between NI points and ASA category in the intraoperative phase ($r=0.39$, $p<0.0001$). In the preoperative and postoperative phases, the correlations were weak ($r=0.24$, $p<0.0001$, and $r=0.18$, $p<0.0001$, respectively).

There were statistically significant differences in NI points between different ASA categories in the pre-, intra-, and postoperative phases (detailed in Article III, Table 2). In the preoperative phase, ASA category IV patients showed higher NI points compared to patients in ASA categories I or II ($p<0.001$). Patients in ASA categories III and IV had higher NI points than patients in ASA categories I and

II ($p<0.0001$) during the intraoperative phase of perioperative nursing care. In addition, when comparing the NI points of the patients in ASA category III and IV, the latter had higher NI points ($p<0.0001$). The findings in the postoperative phase of perioperative nursing care were in line with the former phases, but the differences were not statistically significant when comparing ASA category I patients with patients in categories II or III to IV (detailed in Article III, Table 2).

Intraoperative NI correlated weakly with the PACU time (r=0.21; p<0.0001). The PACU time indicated the time that the patient was under persistent monitoring and surveillance. The average PACU time was 2.4 hours, ranging from 15 minutes to 13.3 hours. High NI during the surgical procedure indicated that the patient might require longer postoperative monitoring before transferring to the follow-up unit.

The intraoperative NI also positively correlated with the duration of the surgical procedure (r=0.49; p<0.0001) and the time that the patients spent in the operating room (r=0.55; p<0.0001). Thus, high NI was associated with a longer surgical procedure and longer stay in the operating room.

The preoperative, intraoperative, and postoperative NI predicted the patient's need for care in the intensive care unit (ICU) after the surgical procedure (p<0.05) instead of the surgical ward. The patients cared for in the day surgery units went home after recovering in the PACU, so in line with this they had significantly lower intraoperative NI points than those patients who were transferred to the surgical wards or to the ICU (p<0.0001) (detailed in Article III, Table 3).

Reliability

Reliability testing showed satisfactory inter-rater reliability. The limit value of agreement percentage (70%) was crossed in the pre-, intra-, and postoperative phases of perioperative nursing care. The highest agreement percentage was in the preoperative phase (100%). In the postoperative and intraoperative phases, it was 78% and 72%, respectively.

Feasibility of the instrument

The electronic survey was sent to 130 perioperative nurses, and 40 of them answered. Thus the response rate was 31%. Almost half of the respondents had over ten years' work experience in perioperative nursing. They performed uniformly in different perioperative nursing roles in their units. In their units, both elective and emergency patients were operated on. Approximately 70% of respondents had earlier experience using some kind of patient classification. The detailed demographics of the respondents are found in Article III, Table 4.

The instrument was regarded as relatively well-suitable or well-suitable for assessing NI in the unit as a whole in 82% of cases. The instrument was described as most feasible in the intraoperative phase (82%) and least feasible in the preoperative phase (55%). In the postoperative phase, the feasibility was 73%.

Also, the instrument was regarded as covering the different dimensions of perioperative nursing relatively well or well by nearly all respondents (92%). On the other hand, 84% of the respondents agreed with the instrument's ability to separate the different dimensions of perioperative nursing relatively well or well.

When the nurses rated the instrument's characteristics (concreteness, usability, understandability, clarity, and objectivity), concreteness received the highest CVI value (0.77), while objectivity received the lowest CVI value (0.74). The rest of the qualities and CVI values were as follows: understandability 0.76, usability 0.75, and clarity 0.75.

## 6.3 Nurse staffing in perioperative nursing

In this chapter, the results describing nurse staffing in perioperative settings are presented based on our integrative literature review. A more detailed report about this review will be published as PAPER IV.

Nine papers were selected for the review. In the literature concerning nurse staffing in perioperative settings was found two guidelines (published by AORN 2014 and ASPAN 2015), two project reports, two studies illustrating the relationships between the members on the surgical team, studies discussing the optimal size of the surgical team, the optimal length of the nurses' working shift, and the impact of surgeons' case sequencing for nurse staffing requirements.

Both guidelines highlighted patient safety as the highest priority when making decisions concerning nurse staffing. In addition, the nurses' right to a healthy and safe working environment is emphasized in both guidelines. The following recommendations for the number of nurses in different phases of perioperative process were made.

Preoperatively (preadmission and on the day of surgery or procedure, or performance in the holding area), no exact staffing ratios are recommended because the performance has much variation in this phase (ASPAN 2015). Intraoperatively, the number of nurses per operation or surgical procedure should be at least two: one RN circulator and one scrub RN (or surgical technologist). More than one RN circulator may be required based on a patient's acuity. A nurse's competency must also be noticed (AORN 2014).

The postoperative phase (PACU) is divided into different levels of care: Phase I, Phase II, and extended care. The recommended nurse-to-patient ratios in Phase I varies from 1 nurse per 2 patients to 2 nurses per patient; in Phase II from 1 nurse per 3 patients to 1 nurse per patient; and for the extended level of care, from one nurse to three to five patients (ASPAN 2015).

Therefore, the guidelines offer a framework by recommending nurse-to-patient ratios for different phases on the surgical patient's perioperative care continuum. AORN's guidelines (2014) also present a formula for calculating full-time equivalents (FTEs) on the unit level. With the help of these guidelines, it is possible to manage both short-term and long-term nurse staffing.

However, it is emphasized that despite these recommendations in the guidelines, every health care organization is responsible for its policy (AORN 2014, ASPAN 2015). According to AORN (2014), several aspects should be taken into consideration when staffing plans are implemented. Competency of personnel and their skill mix, demands concerning technology and practice standards, laws, regulations, and accreditation requirements concerning health care and staffing should be noticed even if the focus should be on the unique and individual needs of a patient.

Two project reports concerned nurse staffing (Mamaril et al. 2007, Butler et al. 2012). Mamaril et al. 2007 reported that scientific evidence for nurse staffing in postanesthesia settings was scarce in expert opinions and consensus. In their project, they validated the aforementioned ASPAN's nurse-to-patient ratio recommendations (Mamaril et al. 2007). Butler et al. (2012) reported a project that developed a tool designed for nurse managers to help them defend their requests concerning nurse staffing. Although the tool was tested in this project, more research was recommended about its effects on organizational outcomes (such as economy and productivity), on staff-related outcomes (such as staff engagement), and on patient-related outcomes (such as quality of patient care). Both project reports called for nursing-sensitive outcomes and their indicators (Mamaril et al. 2007, Butler et al. 2012).

In two studies, the focus was on mutual relationships between the members of surgical teams representing different surgical specialties (Andersson & Talsma 2011, Sykes et al. 2015). In both studies, the teams consisted of a surgeon, their registrars, an anesthesia provider, a circulating RN, and a scrub RN (or technician). Sykes et al. (2015) also included an RN on the team—an anesthesia assistant.

"Core team members" and "periphery nurses" were identified by using a social network analysis. Core team members are often RNs who have deep skills in specific issues and are thus capable of enhancing communication between team members and sharing their knowledge with others. They have the potential to affect the work environment, such as the team's norms, work culture, and work procedures. Periphery nurses are multi-skilled, flexible, versatile and are capable of transferring fluently between the teams. Knowing the nurses' positions in a social network helps in optimizing nurse staffing because every nurse's strengths can be utilized (Anderson & Talsma 2011, Sykes et al. 2015).

The rest of the papers had no similarities, but they aimed to optimize nurse staffing. One discussed the optimal amount of nurses during an operation or surgical procedure in general (Cassera et al. 2009), one simulated the optimal length of a nurse's shift (Pandit & Dexter 2009), and one tested whether the staffing requirements for the holding area or postanesthesia care unit depends on that surgeons' sequencing of cases (Marcon & Dexter 2007).

In the study by Cassera et al. (2009), the surgical team consisted of a surgeon, a surgeon assistant, an anesthesiologist, and all the nurses present during the operation. The team size was determined to be the team members who were present at some time during the operation or surgical procedure. The turnover was due (among other things) to coffee breaks, lunches, and working shifts.

On average, the size of the surgical team was eight members (ranging from 4 to 15). An average of four nurses (a scrub nurse or a circulating nurse) were present. Two scrub nurses assisted 48.1% of the operations. One scrub nurse was involved in 29.2% of the operations. Two circulating nurses were present in 41.7% and one in 28.1% of the cases. Four or more scrub nurses and circulating nurses were present in 4.2% and 5.5% of the operations. The large number of nurses involved in operations indicated the high turnover.

The results show that if the team size increased, the duration of the operation also increased, even when the complexity of the operation and condition of the patient were kept constant. This increase was 15.4 minutes if one person was added to a team. This increase was explained by the turnover's negative effect on communication and coordination when several nurses are involved and reporting and exchanging knowledge. In order to optimize the performance of surgical teams, Cassera et al. (2009) concluded that nurses' turnover during the operations or surgical procedures should be minimized because the turnover has an impact on the surgical team as a whole.

Pandit and Dexter (2009) were also interested in optimizing the effectiveness of nurse staffing in perioperative settings, aiming to avoid overtime expenses. Determining the break-even point where eight-hour staffing would be sufficient, they suggested that if the daily actual hours of OR time used averaged less than 8 hours 25 minutes, then an 8-hour staffing plan would be appropriate. On the contrary, if the actual hours more than 8 hours 50 min, a 10-hour staffing plan would be better. Between these break-even points, conducting a full analysis using historical data, as reviewed in the article by McIntosh et al. 2006, was recommended. In this study, the number of nurses in OR was not described.

Marcon and Dexter (2007) studied recovery area (PACU) and holding area nurse staffing requirements influenced by surgeons' sequencing of their cases. They found that case sequencing had minimal effects on staffing requirements both before surgery in holding areas or postoperatively in postanesthesia care units (PACUs). This result was explained by the inherent variability of cases for each surgeon that led to random sequencing, and therefore the impacts were moderated. A recommendation of matching nurse staffing to the workload was made because efforts to standardize the workload are ineffective.

## 6.4 Summary of the results

In summary, the following findings can be highlighted.

The most crucial core elements of perioperative nursing were those representing patients' safety or patients' physiological needs. Those representing psychological needs like supporting patients' coping strategies and mental wellbeing, communicating with significant others, or receiving information were considered less import but were nevertheless seen as core elements of perioperative nursing.

An instrument consisting of four principal components was suggested based on principal component analysis. However, it revealed that patient's care needs varied in different phases of perioperative nursing, and consequently the content of the suggested instrument was different in the intraoperative and the postoperative phases.

The validity of the instrument was sufficient. A comparison of points by the NI instrument with the ASA Physical Status Classification revealed that although those patients with a high ASA class more often had a high intraoperative NI, the patients in a low ASA class did not automatically have fewer intraoperative care needs. The length of stay in the PACU could be predicted by the intraoperative NI and type of follow-up unit.

In inter-rater reliability testing, the limit value of agreement percentage (70%) was exceeded in the pre-, intra-, and postoperative phases of care. The highest percentage of agreement was in the preoperative phase, and the lowest was in the intraoperative phase.

The instrument was considered most feasible in the intraoperative phase and least feasible in the preoperative phase. The instrument was unanimously regarded as covering the different dimensions of perioperative nursing. The instrument's characteristics—concreteness, usability, understandability, clarity, and objectivity—were appraised as acceptable.

Evidence concerning nurse staffing in perioperative settings was scant and weak; the grade for recommendation varied from C to D. (See http://www.cebm.net/oxford-centre-evidence-based-medicine-levels-evidence-march-2009/.) Staffing models in relation to perioperative nursing-sensitive outcomes were not reported. The need for taking into account patients' care needs or nursing intensity showed up in same papers, but these were not expressed as an measurable form.

However, relationships between surgical team members (Anderson & Talsma 2011, Sykes et al. 2015), the optimal number of nurses during an operation or surgical procedure (Cassera et al. 2009), the optimal length of nurses' shifts (Pandit & Dexter 2009), and the nurses' workload (Marcon & Dexter 2007) should be paid attention to.

# 7 DISCUSSION

## 7.1 Discussion of the results

The premises of this study were a surgical patient and his/her care needs in perioperative settings and a perioperative nurse, who evaluates patient's care needs in order to responding to these needs. A nurse manager needs information from clinical practice in order to warrant the conditions for nurses who respond to patients' care needs while they deliver safe care of good quality. Valid and reliable instruments are needed for valid and reliable information production, but other points of view are also involved in the accuracy of the instrument's use and information input.

This section discusses the results—first concerning the core elements of perioperative nursing, then the validity and reliability of the instrument, and finally nurse staffing in perioperative settings.

### *7.1.1 The core elements of perioperative nursing*

When identifying the core elements of perioperative nursing in the first phase of this study, a consensus was reached after two Delphi rounds representing 55 panelists. The Delphi panelists rated the core elements concerning patient's safety as most relevant in perioperative nursing. This finding is understandable because of the environment where perioperative nursing occurs. In perioperative nursing, the nurses' work concentrates on ensuring patient's safety and preventing complications, which may occur due to the surgery and anesthesia (Bull & & FitzGerald 2006).

Safety aspects related to aseptic have been previously identified as a crucial part of perioperative nursing in the study by Junttila et al. 2005. After the first Delphi round, core elements concerning aseptic performance (3) were modified, and after these modifications the importance was also on a high level also in Delphi round II. Based on our results, perioperative positioning of the patient was seen as a relevant part of perioperative nursing. The patients are at risk for positioning injury and for impaired skin integrity. Prevent these risks is very important in perioperative nursing interventions (Junttila et al. 2005).

As Bull & FitzGerald (2006) have earlier stated, nurses in perioperative settings focus on ensuring patients' safety. In this study, medication safety was also highly valued. The core elements “administrating anesthetic medication” and “administrating medication” were modified after the first Delphi round to “administrating systemic medication.” The core element “administrating local medication” was the same in both Delphi rounds.

Safety issues applied to assessing medical history of the patient, arranging patient care, reporting and documenting the care, and ensuring continuity of care were also seen as relevant when discussing the content of perioperative nursing. In their study, Lindwall & Post (2009) also highlighted the importance of continuity in nursing care as a part of patient safety. Different kinds of specimens are often taken or examinations performed to monitor the patient’s status during an operation or surgical procedure and/or to confirm the diagnosis. Specimens are often needed to guide the care after surgery, thus ensuring the continuity of care. The core element concerning these issues was also regarded as relevant in this study.

When discussing safety issues in perioperative nursing, it has to bear in mind that nursing care takes place in multiprofessional teams, so patient safety is also related to elements other than nurses’ performance (Catchpole et al. 2008, Yukes et al. 2008, Manser 2009, Flin et al. 2011, Mitchell et al. 2011, Mitchell et al. 2013, Lyk-Jensen et al. 2014). For example, the use of WHO’s Surgical Safety Checklist improves patient safety by reducing the rate of deaths and surgery-related complications (Haynes et al. 2009).

In this study, the core elements describing physiological needs—including physiologic responses in circulation, fluid balance, respiration, and body temperature—were all seen as highly important by the Delphi panelists. Most surgical patients in operating departments are at risk of hemodynamic and respiratory imbalance as fluid and electrolyte balance impairments (Petersen 2007). The importance of nursing interventions to keep patient’s temperature normal during perioperative care to prevent inadvertent hypothermia has also been largely recognized in earlier studies (e.g. Scott & Buckland 2006, Kiekkas et al. 2011, Knaepel 2012, Giuliano & Henricks 2017). Obviously, in an environment where a surgical procedure and anesthesia are required to intervene in a patient’s physiological balance, ensuring vital functions is an essential part of nursing care.

Unpleasant symptoms (pain, drowsiness, difficulty with breathing, nausea, and vomiting) are common in the recovery area (Gilmartin & Wright 2008). In this study, after the first Delphi round, “nausea” was suggested by the panelists and was added to the list of core elements because of its clinical relevance. The core element “pain” was regarded as relevant in both Delphi rounds.

The core elements representing psychological needs such as supporting a patient’s coping strategies and mental wellbeing, communicating with significant others, or receiving information were not seen as fundamental as those describing physiological needs. However, patients need relevant information throughout the whole continuum of their care, which includes the operating department (Junttila et al. 2005, Rhodes et al. 2006, Gilmartin & Wright 2008). Gilmartin & Wright (2008) have pointed out that nurses may not recognize the patients' need for ongoing psychological support, because patients' feelings of abandonment are common during perioperative care. On the other hand, Junttila et al. (2005) found that perioperative nurses highlighted supporting the patients' perioperative coping. In the perioperative period, anxiety among patients has also been recognized (Mitchell 2003). Patients in perioperative settings are highly vulnerable due to the surgery and anesthesia, and they need nurses' advocacy (Munday et al. 2014) and appreciate a caring encounter with the nurses to have individual and dignified nursing care (Pulkkinen et al. 2015).

Family members also have informational needs, and they need emotional support (Majasaari et al. 2005). In this study, the patients' need to communicate with their significant others was seen as less important than the patients' need to get informed. Supporting patients' coping strategies and strengthening their mental well-being were not considered as important as elements related to safety and physiological balance. This may be because in our data, day surgery patients were in the minority, and in other perioperative settings family members and significant others are not much involved. However, from the patients' point of view, they appreciate the presence of their family members, and this has positive effects such as decreasing stress and anxiety as increasing patient satisfaction (Majasaari et al. 2005, Rhodes et al. 2006). The presence of parents is especially during at the beginning of anesthesia to reduce children's anxiety and ensuring family-centeredness of care (Romino et al. 2005).

To conclude, the first phase of this study confirmed previously reported and named essential aspects of perioperative nursing. They were gathered together and verified as core elements of perioperative nursing, illustrating the content of perioperative nursing. Based on that, the content of NI instrument was raised.

#### *7.1.2 The validity and reliability of the instrument*

Next, the previously identified core elements of perioperative nursing were implemented as items to the instrument, and construct validity testing was conducted in one university hospital where three operating departments were involved (Paper II). Pre-, intra-, and postoperative phases of perioperative nursing process were involved, and PCA testing was intended to take place in all three phases. Unfortunately, in the preoperative phase, there were so many missing values that PCA could not be performed, and no conclusions could be made about the instrument's structure for the preoperative phase. Preoperative assessments were mainly done in day surgery units, and our instrument produced data with scant deviation among the variables. This was an unexpected result, which we had not taken into consideration when recruiting the units.

After conducting the PCA, a model of four principal components was suggested both intraoperatively and postoperatively. The items were loaded differently for those four principal components in both phases. The results of the PCA have been reported in detail in Paper II.

The items "Assessing the patient's medical history" and "Arranging the patient's care" were grouped together in both phases, emphasizing the importance of ensuring safe nursing care with continuity throughout the surgical patient process. In addition, Lindwall & Post (2009) have highlighted the importance of continuity in the perioperative process to ensure safety in nursing. Both patients and their significant others have informational needs, which have been recognized earlier (Rhodes et al. 2006, Gilmartin & Wright 2008) as patients' needs for emotional support (Gilmartin & Wright 2008, Lindwall & Post 2009, Pulkkinen et al. 2015). In line with this, we also found the items "Patients' need for information" and "Patients' coping mechanisms and mental wellbeing" to be together both in the intraoperative and postoperative phases. Gillespie et al. (2012) have also identified empathy as one perioperative nursing competency.

Both in the intra- and postoperative phases, items describing fluid balance and circulation appeared together as items related to arranging the patient's position and noticing his/her activity- or rest-related physiological responses. These items illustrate the mutual content of nursing activities during the surgical procedure and in the PACU (see also AORN 2014, ASPAN 2015).

Differences between the phases were found concerning the items related to aseptic. All these three items appeared together only in the intraoperative phase of care, which is natural because the surgical procedure occurs then. In addition, the item describing how to manage the specimen collection and how to the handle and order the examinations emerged only in the intraoperative phase.

According to our results, patients have a wide range of care needs during the phases of perioperative nursing care. So PCS, as presented by Edel (1995), where patients were categorized according to issues—such as how complex equipment and instrumentation is needed; how many prep, incision, or limb sites a patient has; what kind of position he/she needs; and what are the supplies of the specialty—is limited to capture even the most common care needs in perioperative settings. In line with suggestions made by Harper & McCully (2007), our results highlighted that psychological and social needs are also an essential part of good nursing care in perioperative settings.

Both intraoperatively and postoperatively, the majority of items were loaded into the first PC. In both phases, the model of four principal components was suggested. However, it revealed that although the number of principal components was equal in both phases, the loaded items varied. This variability probably illustrates the differences in nursing care activities with different concerns and emphasizes patients' changing care needs during the surgical procedure compared to the post-anesthesia care unit. However, the model of four principal components explained over 50% of the variation, which can regarded as an adequate result.

Our findings raise the question about the uniform instrument's suitability for different phases of perioperative care. If the theoretical background and clinical environment are not equal, can it be measured with a uniform instrument? On the other hand, in daily nursing performance, it could be challenging to use and maintain two different instruments while nurses usually work in both intra- and postoperative environments.

Being aware of these concerns, we decided to continue instrument testing with a uniform instrument consisting of six categories instead of four. In both four-category instruments, the first categories were prominent and consisted of numerous patient's care needs. Therefore, the six-category instrument had the more precise clinical relevance. In addition, we considered it difficult for perioperative nurses in clinical practice to use two different instruments in the intra- and postoperative phases. And lastly, other instruments in the RAFAELA® system include six categories; so in line with this, we prefer the six-category instrument (e.g. Andersen et al. 2014, Fagerström et al. 2014, Flo et al. 2016, Fagerström et al. 2018). The national workgroup agreed with the six-category instrument structure while accepting a certain roughness in the NI assessment.

Nine operating departments representing different fields of surgery from five university hospitals were recruited. Three kinds of data were collected. First, the perioperative nurses gathered data by assessing NI from their patients (N=876). Divided into the three phases of perioperative nursing, there were 265 assessments for the preoperative phase, 846 for the intraoperative phase, and 609 for the postoperative phase of perioperative care. Second, the perioperative nurses made parallel assessments (n=144). Third, the perioperative nurses who had used the instrument (n=40) were surveyed.

The ASA is a simple method for anesthesiologists to evaluate a surgical patient's preoperative physiological status (American Society of Anesthesiologists 2014).

When examining the correlations between NI and the ASA, it was revealed that there was an association between ASA class III and IV given by anesthesiologists, but not between ASA class I and II. This means that the patients with a high ASA class had high nursing care needs during the intraoperative and postoperative phases of care; but it does not mean that patients with low ASA scores might not need demanding nursing care during these phases. NI points for ASA class I patients ranged from 6 to 20, both in the intraoperative and postoperative phases. For ASA class II, the range was from 6 to 22 in the intraoperative phase, and 6 to 15 in the postoperative phase. Thus, we have to keep in mind that patients with a low ASA class may have demanding care needs intra- or postoperatively, so The ASA class does not necessarily predict nursing care needed in perioperative settings. Earlier, AORN recommended using the OR Patient Classification for Staffing Assignments by calculating together the ASA class and the complexity of operation or surgical procedure instead of NI (Bell 2015).

In the preoperative phase, the data were not representative because this phase was skipped in many operating departments involved. This means that the patients were transported straight to the operating room without any interventions in the holding area. The results concerning the preoperative phase must therefore be interpreted with caution.

In predictive validity testing, we found a correlation between NI and length of PACU time, indicating that the length of stay in the PACU may be predicted with intraoperative NI, and a patient's need for intensive care after surgery may also be predicted with both intra- and postoperative NI—the latter because of the correlation found between NI and the type of follow-up unit. Therefore, based on this substudy, by combining information provided by the NI instrument and ASA, it could probably be possible to more accurately predict the patient's need for extended PACU time or the need for intensive care after the surgical procedure than with either one alone.

On the other hand, the correlation between ASA category and length of hospital stay is contradictory (El-Haddawi et al. 2002, Carey et al. 2006, Torkki 2006, Ranta et al. 1997, Cuvillon 2011, Daapis 2011). When anticipating postoperative complications, the correspondence with ASA and several postoperative outcomes (like complications and mortality) has been studied, and correlations have been found (Wolters et al. 1996, Prause et al. 1997, Leunn & Dzankie 2001). In this study, the correlation between NI and complications was not evaluated.

Intraoperative NI correlated positively both with the duration of the surgical procedure and the time the patient spent in the operating room. In the future, systematic use of the NI instrument may have the potential to produce and create big data for developing predictive models for nurse staffing purposes and performance planning.

In reliability testing with parallel assessments made by two nurses independently, the agreement percentage was in every phase over the chosen limit value of 70%. We consider this promising, although more testing is needed with data gathered at the department level. In other studies concerning inter-rater reliability of the NI instrument of RAFAELA® systems, the results have been similar (e.g. Frilund & Fagerström 2009, Andersen et al. 2014, Van Oostveen et al. 2016).

A survey of the users addressed the instrument's comprehensiveness and sensitivity. Concreteness, usability, understandability, clarity, and objectivity were considered to be rather homogenous. Because practice was needed in using our instrument, and the data collection time was only two months, we consider this as acceptable. The response rate was only 31%. Therefore, conclusions must be drawn with caution. In the preoperative phase, the results were poorer than in the intra- and postoperative phases. In the preoperative phase, the number of patients was scant, which might have led to difficulties in evaluating the instrument. Van Oosveen et al. (2016) studied the feasibility of the RAFAELA® system, and they found that the users perceived the ward-specific NI instrument suitable for measuring all aspects of NI.

According to our validity testing, the results support the use of the NI instrument in perioperative settings. This finding has been earlier verified in studies concerning nursing environments other than perioperative (Fagerström & Rauhala 2007, Fagerström 2009, van Oostveen Andersen et al. 2014, Van Oostveen et al. 2016). The information derived from data gathered by nurses from the patients' care needs seems to be valid and reliable to use as part of a knowledge-based management tool kit. Still, more research is needed to demonstrate a possible association between NI and nursing-sensitive outcomes, as patient safety incidents and mortality, as demonstrated in the study by Fagerström et al. 2018.

### *7.1.3 Nurse staffing in perioperative settings*

This chapter describes nurse staffing in perioperative settings. (See Paper IV for more detail.)

We did not find much scientific research concerning nurse staffing in perioperative settings in our integrative review. This was despite recognizing the importance of decisions concerning nurse staffing at several levels of nursing management (Sirala et al. 2016). NICE (2014) gives staffing recommendations for wards or shifts.

In perioperative settings, ASPAN (2015) gives recommendations for nurse-to-patient ratios, both pre- and postoperatively. In addition, AORN (2014) recommends one circulating nurse, one scrub nurse, and one nurse anesthetist working with an anesthesia provider per patient as standard staffing intraoperatively. If surgical complexity or the severity of the patient's condition increases, the number of nurses has to increase. Needleman et al. (2011) have highlighted matching patients' needs with the number of nurses in other nursing environments. As AORN (2014) stated that when allocating nurses in ORs, one must take into account the technological demands of the surgery, practice standards, staff members' competency and their skill mix, and laws, regulations, and accreditation requirements related to staffing and health care.

Evidence exists for associating a higher proportion of registered nurses with better outcomes and safety of care (Pearson et al. 2006, Kane et al. 2008, Stone et al. 2008, McGahan et al. 2012, Diya et al. 2012). Associations between optimal nurse staffing and positive patient outcomes have been identified (Bray et al. 2010, Bledgen et al. 2011, Aiken et al. 2014, Cho et al. 2016). On the other hand, inadequate nurse staffing has been associated with negative patient outcomes (e.g. Needleman et al. 2011, Junttila et al. 2016). These findings are not directly transferred to perioperative settings, as more postoperative complications occurred if a higher number of nursing personnel were involved during an operation (Talsma et al. 2013). Besides, Newhouse et al. (2005) have tried but failed to find connection between the proportion of RNs and patient outcomes in perioperative settings. In our review, we did not find evidence of associations between nurse staffing and patient outcomes in perioperative settings.

In addition, with respect to surgical team size (the number of personnel present during the operation or surgical procedure), it was found that adding one person to a surgical team predicts a 15.4-minute increase in procedure time when all other variables are constant (Cassera et al. 2009). This indicates that it would be important to minimize nurses' turnover during operations or surgical procedures. Surgical team size was determined in the papers of our review as follows: at least an RN circulating nurse, an RN scrub nurse (can be replaced with a surgical technologist in some organizations), and as a working partner for an anesthesiologist there may be a nurse anesthetist (Anderson & Talsma 2011, AORN 2014, ASPAN 2015, Butler et al. 2012, Pandit & Dexter 2009, Sykes at al 2015). In one study (Cassera et al. 2009), no nurse anesthetists were involved on the surgical team. In earlier studies, the number of nurses, especially understaffing, has been proven to affect nursing care delivery (Alfedsdottir & Bjornsdottir 2008, Garret 2008, Bledgen et al. 2011, Twigg et al. 2015, Junttila et al. 2016).

AORN (2014) presented a formula to calculate the total number of full-time equivalents (FTEs) for the intraoperative phase of care in perioperative settings. A corresponding formula for anesthetist nurses was not found, either for the operating room or pre- and postoperatively. Intraoperatively, this may be explained by the policy of allocating one anesthesiologist per operating suite; but pre- and postoperatively, long-term nurse staffing with the number of FTEs may also be valued.

To focus only on the numbers of perioperative personnel (including perioperative nurses) is not sufficient for staffing purposes because patient outcomes also depend on the quality of teamwork in communication and cooperation (e.g. Makary et al. 2006, Weaver et al. 2010, Takala et al. 2011, Daniels & Auguste 2013, Kawano et al. 2014). These findings are in line with the studies by Anderson & Talsma (2011) and Sykes et al. (2015). They both discussed how the team members' positions in a social network could be used to enhance the quality of teamwork in surgical teams. So-called core members are capable of sharing knowledge and skills among surgical team members because they have deep competence in some narrow area. In contrast, the so-called peripheral members have a wide range of skills, flexibility, and versatility. They could serve as change agents to spread new culture, performances, and practices.

The biggest bottleneck for efficient performance in Finnish hospital districts is non-optimal staffing (Peltokorpi et al. 2010). The need for staffing models that could predict productivity and budgetary demands has been recognized (Butler et al. 2012). In our review, Marcon & Dexter (2007) examined the need for nurse staffing in holding areas and PACUs, and they stressed the importance of optimal nurse staffing as a long-term challenge rather than trying to match the workload to staffing on a daily basis. According to them, the staffing plan should be based on knowing the hours needed to be staffed. Pandit & Dexter (2009) determined the break-even point where the normal eight-hour staffing is enough, and conversely, when ten-hour staffing would be better economically. Working overtime is expensive, so unnecessary staffing hours should be avoided. Also, nurse managers need tools to support their requests concerning nurse staffing (Butler et al. 2012).

This review raised some questions. It was mentioned that in staffing requirements and decisions concerning nurse staffing, patient acuity (Mamaril et al. 2007, AORN, 2014, ASPAN 2015) or patients' needs (Sykes at al. 2015) should be noticed. What was meant by patient acuity and patients' needs and how they should be evaluated remains unknown.

Butler et al. (2012) announced the need for a scientific method for nurse staffing in perioperative settings. Commonly, historical data from performance combined with workload calculations guide nurse staffing decisions in perioperative settings and in other environments of nursing performance, too (see Fagerholm 2014). This so-called “best guess” strategy is not enough for knowledge-based management (Butler et al. 2012).

In perioperative settings, the research in the area of nurse staffing overall seems to be rare (Butler et al. 2011). However, some conclusions could be drawn: The number of FTEs, the number of nurses pre-, intra-, and postoperatively (Mamaril et al. 2007, AORN 2014, ASPAN 2015), the unique, individual needs of a patient (AORN 2014, ASPAN 2015), technological demands and standards of the surgery, personnel’s competency and skill mix, laws, regulations, and accreditation requirements related to staffing and health care should be noticed (AORN 2014).

Nurse staffing in perioperative settings must be considered in a broader context than just the number of nurses, because other professions are involved. Surgical teams are multidisciplinary, often consisting of at least a surgeon and anesthesiologist, along with a scrub nurse, a circulating nurse, and a nurse anesthetist. However, nurses are the major profession group in perioperative settings, and therefore the need to succeed in their allocation is of high importance. Both AORN and ASPAN also highlighted the nurses’ right to a safe work environment while taking care of their patients. There is evidence that optimal nurse staffing reduces job dissatisfaction and burnout (Aiken et al. 2002, Rafferty et al. 2007, Toh et al. 2012) and sickness absenteeism (Rauhala et al. 2007).

## 7.2 Strengths and limitations of the study

In this section, the strengths and limitations of this study are discussed in chronological order by phase.

In relation to the first phase of this study, some potential concerns with respect to the Delphi technique has been identified (Hasson et al. 2000, Keeney et al. 2001, Keeney et al. 2006), which may lessen its scientific validity. We tried to tackle them by choosing the panelists to cover geographically as extensively as possible the whole of Finland, but also the scene of perioperative nursing. The panelists represented 15 hospital districts in Finland, as the total number of them was 21. The panelists represented expertise in the clinical practice of perioperative nursing and in its management, education and research.

In the Delphi technique, two rounds are often considered as enough to achieve a consensus (Keeney et al. 2006). In this study, the response rate decreased in Delphi round two, which often happens. This probably caused bias in the results, although the results for Delphi round two confirmed the results from the first Delphi round.

The identity of the panelists remained anonymous to the researcher, so they would feel free to express their opinion.

In the next phase, the relatively small sample size when testing the construct validity of the NI instrument has to be born in mind. In addition, the data concerning the preoperative phase of care was so scant that any conclusions could not be made for this phase, although we aimed to test all three phases of perioperative nursing.

In the following phase of this study, where the data were gathered from nine operating departments from five university hospitals representing different surgical fields, the data was larger, which strengthens interpretation of the results. In this phase, it must be noticed that the testing was conducted with a six-category instrument, which was not the suggestion based on the PCA in the earlier phase. We preferred clinical relevance in the six-category instrument, in the line with the agreement of the national workgroup, which initially suggested the core elements evaluated in the first phase of this study. In addition, other arguments supported this decision. An equal instrument, which is not dependent on the phase the nurses practicing within perioperative nursing care, was more preferable. Also, the future benchmarking possibilities with other six-category NI instruments were kept in mind. However, the six-category instrument's content validity was not statistically tested.

We decided to limit both data collection periods where the instrument was tested and used by perioperative nurses as a part of their daily performance. These periods may not have been long enough to capture the diversity of patients' care needs occurring in the departments involved. We also excluded patients whose intraoperative phase of care lasted less than 30 minutes. This was done to ensure safe nursing care of good quality despite the ongoing instrument testing because the data collection required time and effort from the nurses.

The data collection periods were negotiated with the recruited departments. Although these periods were tended to be scheduled so that the performance should have been as normal as possible outside the holiday season, diminished performance occurred in some data collection departments, which naturally reduced the total amount of data. Our decisions and department-related performance reductions may have indirectly affected our results and conclusions.

The nurses needed training in the use of the tested instrument. The principal researcher who gave this training had a strong clinical background and expertise in perioperative nursing. The contents of these training sessions were similar and standardized in all attending departments with tailored patient cases for each department. These tailored patient cases may have hindered the uniformity of the training, but it was done to further the nurses' skills in applying the instrument.

Generally, one limitation may be the subjectivity of the instrument tested. The evaluation of NI is indirect by nature and depends on nurses' experience and skills in assessing patient's care needs. More experienced nurses tend to underestimate their own contribution to nursing care, and less experienced nurses frequently overestimate it. To tackle this and gain maximal objectivity, in the training sessions the scope was on the patient's care needs and the nurse's responses to these needs. NI was evaluated not to demonstrate how demanding nursing care is, but what the patient's care needs are. Unfortunately, in our survey of users, the response rate was only 31%, so the feasibility of our instrument has to be interpreted with caution.

## 7.3 Implications for nursing practice, education and management

Some implications for nursing practice can be drawn. The first verified content of perioperative nursing was implemented with the instrument tested further in this study, so it could be used for introduction purposes for both perioperative nursing students and newly graduated professionals in perioperative units.

Assessing NI is one resource for perioperative nurses to display the visibility of perioperative nursing. It has potential in illustrating the nurses' contribution in surgical patient's care. A perioperative nurse (or a team of perioperative nurses) assesses every patient he/she cares for by using the instrument, so it is his/her professional assessment that counts. Perioperative professionals are highly trusted in information production. No one outside the profession is assessing nursing performance other than the nurses themselves. This may have a positive impact on nurses' professional identity and development.

The instrument may serve as a framework for perioperative nurses, because when the assessment is made, it forces a check that all essential core elements have been taken into account. Therefore, the use of the instrument could serve as a resource ensuring good quality care. In addition, in perioperative nursing curriculums at Finnish universities of applied sciences, our instrument could be a framework when training planning, performing, and assessment of surgical patient's care in the field of perioperative nursing. It is of high importance that nursing students become acquainted with evidence-based nursing care already during their studies.

The main implication for nursing management is the possibility to use a valid tool to monitor patients' care needs. With the information generated from nursing intensity, a nurse manager is able to make decisions concerning nurse staffing and nurse staff allocation based on knowledge gathered from patients by the nurses. Nurse managers are urged to ensure optimal nurse staffing levels for safety and quality of nursing care delivery and thus for good patient outcomes. Besides, they need to create such environments for nurses to work that are healthy and support job satisfaction.

## 7.4 Suggestions for further research

The following suggestions for further research can be made:

1. Testing the instrument further with larger patient groups and in different patient groups in a variety of perioperative settings would gain more evidence of additional value in correlation to current practices in pre-, intra-, and postoperative phases of perioperative nursing, both in clinical practice and (especially) in nursing management.
2. Testing the validity of the PAONCIL instrument for the RAFAELA® system in perioperative settings is needed. Earlier research on the validity of PAONCIL instrument has been made only in relation to the OPCq instrument used in inpatient wards.
3. Testing different ways of allocating nursing staff in perioperative settings. This study reveals that knowledge of differences between various nurse staffing models do not exist in perioperative settings. Knowledge is needed related to both daily management (short-term) and strategic management (long-term) nursing staff allocation.
4. The nursing-sensitive outcome indicators in perioperative settings ought to be determined and the impact of nurse staffing to these outcomes ought to be studied to point out the contribution of perioperative nurses in the process of surgical patient care.
5. Evaluating nurse managers' and nursing leaders' skills and professional competence to utilize knowledge produced by NI is needed to be clarified to achieve the full potential of NI evaluations made by perioperative nurses.
6. Furthermore, studying the value of the NI data from the perspective of nurse managers' and nursing leaders' information needs is suggested.

# 8 CONCLUSIONS

This study determines the core elements of perioperative nursing. The most crucial core elements of perioperative nursing are associated with patient's safety or patient's physiological needs. However, care needs associated with psychological aspects, as giving information, supporting patient's coping strategies and communication with family members, and advancing their mental wellbeing are also involved.

The instrument was designed based on these core elements to evaluate NI in perioperative nursing. The validity and reliability of the instrument are suitable and acceptable. The instrument provides information about patients' care needs in all phases of surgical patient care in perioperative settings and in all kinds of perioperative environments.

Evidence on nurse staffing in perioperative settings is relatively scant. Information about patients' care needs may assist in matching nurse staffing to patients' care needs.

Because perioperative nurses assess their patients' care needs with the NI instrument, and perioperative nurse managers utilize this information gathered for staffing purposes, nursing care for surgical patients in perioperative settings that is safe and of high quality is ensured. However, optimal nurse staffing should also take into account nurses' education, experience, training, and skills.

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