Title: Psychometric validation of the Perceived Perioperative Competence Scale-Revised
in the Swedish context

Running head: Psychometric testing of the Perceived Perioperative Competence scale-
Revised

Authors:

JAENSSON, Maria ¹. RNA, MSc, PhD

FALK-BRYNHILDSEN, Karin ¹. RN, MSc, PhD

GILLESPIE, Brigid M. ² RN, PhD, Professor

WALLENTIN, Fan Y.³ PhD, Professor

NILSSON, Ulrica ¹. RNA, PhD, Professor

1. Faculty of Medicine and Health, School of Health Sciences, Örebro University,
Sweden

2. Centre for Excellence in Nursing Interventions (NCREN), Centre for Health
Practice Innovation (HPI), Menzies Health Institute Queensland (MHIQ), Griffith
University, Australia

3. Department of Statistics, Uppsala University, Uppsala, Sweden

24

25 Corresponding author.

26 Maria Jaensson

27 School of Health Sciences Örebro University,

28 701 82 Örebro, Sweden

29 Phone +4619303405

30 Email: maria.jaensson@oru.se

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45 Why is this research needed?

- 46 • Nurses' competence is correlated with patient safety and high quality care.
- 47 • There is no appropriate instrument to assess perioperative nurses' competence
- 48 in the Swedish context.

49 What are the key findings?

- 50 • The Perceived Perioperative Competence Scale –Revised (PPCS-R.) is valid and
- 51 reliable for measuring the perioperative competence of operating room and
- 52 registered anesthesia nurses in Sweden.

53 How should the findings be used to influence policy/practice/research/education?

- 54 • The PPCS-R. can be used by healthcare organizations to identify individual
- 55 educational needs for operating room and registered anesthesia nurses.

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ABSTRACT

Aim: To psychometrically test the Perceived Perioperative Competence Scale-Revised in the Swedish context.

Background: Professional competence among nurses ensures patient safety and high quality care.

Design: Cross- sectional survey.

Method: The 40- item Perceived Perioperative Competence Scale-Revised was translated into Swedish using a forward-translation approach. A census of 2902 registered nurse anesthetists and operating room nurses was drawn from a database of a national association in Sweden. Data were collected during April and May in 2015 with two follow-up reminders.

Result: The response rate was 39% (n=1033; n=528 registered nurse anesthetists and n=505 operating room nurses). Cronbach's alpha for each factor was 0.77-0.89 among operating room nurses and 0.79-0.88 among registered nurse anesthetists. Cronbach's alpha for the entire sample was 0.85. Confirmatory factor analysis showed good model fit. The highest item loading differed between operating room nurses and registered nurse anesthetists in four factors: skills and foundational knowledge, leadership, proficiency and professional development. The remaining two factors: collegiality and empathy, had the same highest item loading for all nurses.

Conclusion: Psychometric testing of the Swedish translation of the Perceived Perioperative Competence Scale- Revised suggests good construct validity among Swedish operating room nurses and registered nurse anesthetists. Self-assessment of competence offers the opportunity for professional reflection and allows nurse educators to identify strategies to address the learning needs of OR nurses and RNA nurses .

Key words: instrument development, nursing competence, advanced practice nursing,
confirmatory factor analysis

INTRODUCTION

Competence encompasses the cognitive, social and psychomotor skills required for nurses to practice safely. There are compelling reasons for assessing professional competence; without appropriate technical and non-technical skills there is a heightened risk of errors and adverse events [1-3]. Self-assessed competence is a commonly accepted and time efficient approach [4-7]. When investigating agreement between nurse and manager and nurse competence, the managers assessed higher levels of competences than the nurses themselves [8]. When nurses assessed their level of competence, they identified several areas in need of additional education and clinical exposure [9]. Thus, assessing the competence of practicing nurses is an important strategy to identify areas of professional development and practice improvement, and thus ensure that nurses provide patients with high quality and safe care.

Over the last two decades, conceptualizations of nurse competence have been informed by specialty and context. Professional competence in nurses has been described as a process in which the nurse develops from a novice into an expert over time [10]. Generic nurse competence has been described in relation to the helping role, managing situations, the work role, diagnostic functions, teaching/coaching, therapeutic interventions, and ensuring quality [6]. A concept analysis by Smith[11] (2012) exploring the notion of nurse competence, identified nine concepts involved in developing nurse competence: integrating knowledge into practice, experience, critical thinking, proficient skills, caring, communication, environment, motivation and professionalism[11].

More broadly within medicine, Epstein and Hunter proposed that professional competence of physicians and trainees is “the habitual and judicious use of

communication, knowledge, technical skills, clinical reasoning, emotions, values and reflection in daily practice for the benefit of the individual and community being served” [12]. This definition is also applicable to advanced practice nurses such as registered nurse anesthetists (RNAs) and operating room (OR) nurses.

Background

The literature review on competence instruments

Several researchers agree that there is a lack of consensus in defining nurse competence [11-13]. This lack of consensus may be related to the differences in specialty and context, leading to the development and psychometric evaluation of instruments nuanced to different settings with participants of varying levels of clinical experience [4-6, 14]. Table 1 provides a summary of five tools developed to measure nurses ‘competence across various nursing samples and contexts. To date, the only instrument developed specifically for the perioperative context is the Perceived Perioperative Competence Scale- Revised (PPCS-R.)[7].

The perioperative setting

In the perioperative context, surgical teams are comprised of physicians and nurses working in instrument and anesthetic roles, all of whom have circumscribed and well-defined roles [15]. In many instances, surgical teams work together on an *ad hoc* basis; as such membership often changes [16]. While the perioperative nurse may not always work regularly with other members of the surgical team, they must demonstrate knowledge of the procedure itself and particular patient requirements for anesthesia and other factors [17]. This requires nurses to be familiar with using the various surgical instruments and equipment. The fast pace of the work environment means that

perioperative nurses must efficiently manage and coordinate busy lists, and prioritise caseload based on patient acuity and case requirements [18]. The patient is central to the care that nurses provide in the OR, perioperative nurses must work cohesively with other team members to ensure the best possible outcome for the patient [19].

The registered nurse anesthetists and the operating room nurse in Sweden

The RNA is a perioperative nurse with nursing qualification who has undertaken additional education and specialty training in anesthesia. To become a RNA in Europe requires between one and four years of postgraduate education. After accreditation by an anesthesiologist the RNA independently induces, maintains and concludes general anesthesia. RNAs work in several countries, including Sweden, Norway, Denmark, the United States and Switzerland [20]. In addition to having nursing qualifications, the OR nurse has undergone additional postgraduate education in perioperative care, which takes from one to four years. OR nurses' duties encompass instrument and circulating roles. The role is based on the European Operating Room Nurses Association description of competence for perioperative nursing care, underpinned by the model of Tollerud *et al*[21] (1985). Both RNA and OR nurse roles encompass patient safety and advocacy [22, 23].

Aim

The purpose of this study was to test the psychometric properties of the PPCS-R. with a sample of RNAs and OR nurses in the Swedish context. To date, there has been no evaluation of the perceived competence of perioperative nurses in a Swedish setting.

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181 **Design**

182 This methodological study used a cross-sectional survey to evaluate the psychometric
183 properties of the PPCS-R.

184 **Participants**

185 Invitations to participate were sent to RNAs and OR nurses across Sweden. Nurses who
186 worked as OR nurses or RNAs in the perioperative context were eligible; those who did
187 not practice in clinical roles were excluded. The sample was drawn from a census of
188 2901 nurses who were members of the Swedish Association of Health Professionals and
189 had registered their professional role as an OR nurse or RNA. All nurses with an email
190 address were contacted during April and May 2015. Participants were contacted
191 independently through the Association, and so the researchers were blinded to the
192 names of the participants in the data base. Two reminders were sent out during the
193 study period.

194 **Data collection**

195 *Perceived Perioperative Competence Scale-Revised (PPCS-R)*

196 The 40 item PPSC-R uses a 5 point Likert response scale that ranges from 'never' (1)
197 through to 'always' (5). The possible scale scores range from 40 to 200, with higher
198 scores that indicate greater levels of perceived competence. The The PPCS-R. has been
199 evaluated in several cultural contexts including Australia, Canada 24 and Scotland 25,
200 but the instrument is yet to be validated in either a Swedish context or a population of
201 nurse anaesthetists.

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203 *Translation, validation and testing of the PPSC-R*

204 We used a two-phased approach in the translation and testing of the PPCS-R. In phase
205 one, the PPCS-R. was translated from English to Swedish using forward-translation by a
206 professional translator [24]. Following this, three of the authors (all native Swedish
207 speakers, with extensive experience as perioperative nurses) evaluated the content
208 validity of the PPSC-R. items in relation to the Swedish context. The researchers found
209 the PPCS-R. to show face validity; that is assessed the qualities desired in this context
210 [25](p. 6), but, two items were not relevant to the role of RNAs and OR nurses and were
211 therefore not deemed applicable on a conceptual level (Original scale item : *I am*
212 *familiar with most of the instrumentation in different specialties* was changed to *I feel*
213 *comfortable with theatre techniques/ anesthetizing in several surgical specialties* and
214 original item: *When I am allocated to an area of the OR that is unfamiliar, I draw on my*
215 *skills and experience* was changed to *When I have to perform duties in the operating*
216 *theatre which I don't know about, I use my professional expertise and experience*) . These
217 two items were re-worded by the authors, and then back translated to English by
218 another professional translator. The two items were included in the Swedish version of
219 PPSC-R.

220 Phase two involved eliciting feedback from a purposive sample of six expert
221 perioperative nurses (RNAs: n=3, OR nurses: n=3) with a depth of clinical knowledge
222 and experience ranging from 3 to 20 years. These expert nurses gave feedback in
223 relation to the understanding and face validity of items. The questions in the pilot study
224 aimed to elicit feedback based on clarity, understanding and relevance of the items.
225 Feedback from the expert panel indicated that no revisions were required to the
226 instrument.

227 We also collected demographic data including age, gender, level of academic degree and
228 years of experience.

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230 **Ethical considerations**

231 The research team did not have access to the population; all access was provided via the
232 Swedish Association of Health Professionals. Emails were sent to all members who had
233 stated that they worked as a RNA or an OR nurse through the Secretariat of the
234 Association, ensuring that study investigators were blinded to the names of the
235 members listed on the database. The combined participant information sheet and survey
236 was included as an email attachment that explained the nature of the project.

237 Respondents were assured of the voluntary and anonymous nature of participation, and
238 their right to withdraw from the study at any time. Consent was implied by the return of
239 the completed survey to the Association Secretariat. According to Swedish national
240 legislation and directives, formal approval from ethics committee was not required as no
241 intervention was performed and no sensitive information was obtained.

242 **Data analysis**

243 All data were entered and analysed using version 23.0 of the SPSS software package
244 (PASW Statistics®; SPSS Inc. Chicago, IL). Following data cleaning, the analysis included
245 descriptive statistics which were determined by the level and distribution of the data.
246 Age, gender, experience and academic degree were analysed with descriptive statistics
247 as means (SD), absolute numbers and percentages. For between-groups comparisons,
248 and independent t-test or the Mann-Whitney U-test was used as appropriate.
249 Cronbach's alpha was used to measure internal consistency, with a value of 0.7
250 considered acceptable [25].

Confirmatory factor analysis (CFA) is a technique used for testing hypothesis arising from theory [26]. In this study, we used CFA to confirm the structure of the PPCS-R using the six latent factors identified in an earlier exploratory factor analysis [7]. To evaluate the model, the following goodness-of-fit indices were considered:

- a) *Standardized root mean square residual* (SRMR): values lie between 0.0 and 1.0, and 0.0 indicates perfect fit [26]
- b) *Normed fit index*(NFI) : values lie between 0.0 and 1.0, with a cut-off of 0.95 for a good model fit[26].
- c) *Root mean square error of approximation* (RMSEA): a value of around 0.06 or less indicates that the model fits the data closely, while values between 0.06 and 0.08 indicate an acceptable fit [26].
- d) *Item-factor loading*: values exceeding 0.30 are regarded as acceptable[27] and *T-values* ≥ 2 are considered to be significant ($p < 0.0001$).

A maximum likelihood estimation method was used for the analysis. Since all the variables were ordinal, the polychoric correlation matrix of the observed variables was computed and applied in the analysis. The analysis was performed using version 8.80 of the Linear Structural Relations (LISREL) software package [28].

RESULTS

The web-based questionnaire was sent to 2902 perioperative nurses, 129 of whom (5%) had a non-functioning email address. Of the remaining 2773, 94 (3%) stated that they no longer worked in the perioperative role and were therefore excluded from the analysis leaving, 2679 eligible respondents (92%). The final response rate was 39% ($n=1033$), including 505 OR nurses (49%) and 528 RNAs (51%) (Table 2). Most (87%) survey respondents were women, while the majority of the sample had more than 11 years of

working experiences, 31% (n=320) had a Bachelor's degree, and 21% (n=217) had a Master's degree. The questionnaire had missing responses for every item.

Internal consistency

The six factors and 40 items of the translated version of the PPCS-R had Cronbach's alpha values of 0.77-0.89 for the OR nurses and 0.79-0.88 for the RNAs (Table 3). Cronbach's alpha for the total sample was α 0.85 while for RNAs and OR nurses, was α 0.76

Confirmatory factors analyses

Before we proceeded with a CFA, an exploratory factor analysis (EFA) model was undertaken. The results from the EFA suggested that a six-factor model should be able to count the inter-correlations of the entire items. Two models were identified, one for OR nurses and the other for RNAs. The goodness-of-fit values were used to evaluate the internal construct validity for the OR nurses and RNAs. The p-values of chi-square tests for both groups were > 0.05 , indicating that the six-factor model did not fit the data closely. The SRMR values: indicated good model fit for both groups (OR nurses: 0.067 and RNA: 0.065). RMSEA values showed that the model fitted the data (OR nurses: 0.065 and RNA: 0.061), and the NFI values in both groups lay within the range for a good model fit (OR nurses and RNA: 0.95).

The test reliability among the factors showed that the inter-scale -correlation ranged from 0.399 to 0.828 in OR nurses and 0.345 to 0.801 in RNAs (Tables 4 and 5). The correlations of all six factors in both groups were significant at the 5% level. The lowest correlations were seen between "empathy" and "skills and knowledge" in OR nurses and

“collegiality” and “skills and knowledge” in RNAs. The highest correlations were seen between “proficiency” and “skills and knowledge” in both groups.

The factor structure of the responses was analysed. As shown in Table 6, no factor had a loading below the acceptable threshold of 0.3. Among the OR nurses items 21, 27 and 28 had low item-factor loadings of 0.351, 0.306 and 0.386 respectively. All other items had factor loadings between 0.419 and 0.864. Among the RNAs, items 25, 27 and 29 had low item-factor loadings of 0.399, 0.309 and 0.379 respectively. All other items had item-factor loadings between 0.409 and 0.839. In two factors, OR nurses and RNAs had the highest factor loadings in the same item.

The “collegiality” factor had highest factor loadings in the item “I tailor my communication based on a mix of personalities in the team” (OR nurses: 0.664, RNAs: 0.617). The “empathy” factor had, highest factor loading in the item “I establish rapport with patients that enhances their ability to express feelings and concerns” (OR nurses: 0.864, RNA: 0.545).

In summary, the CFA results indicate an acceptable model fit for both groups and the factor loadings were all statistically significant.

DISCUSSION

To our knowledge this is the first article to report psychometric properties of the PPCS-R using CFA, in a setting that includes both OR nurses and RNAs. Our study is also the first to report these properties in the Swedish context. The PPCS-R. was originally developed and psychometrically tested in 2012, in an Australian population of OR nurses [7] and has since been used in a Canadian [29] and a Scottish [30] population of

OR nurses. However, in the above mentioned studies [29, 30] construct validity testing did not include CFA. It is imperative that a model based on theory and/or previous analytic research should be tested if used in a new context or a second time in case a hypothetical model fails to fit appropriately [28].

The translation of the instrument was undertaken using a forward-translation method [24]. The goal was to have equivalence between the original and the Swedish version. In order to achieve equivalence in interpretation and conceptual meaning, three of the authors (all Swedish researchers with experience of working as an OR nurse or RNA) discussed conceptual equivalence. Examination of item equivalence led to changes in two items in the PPCR-R in order to make it acceptable and appropriate for the target population and context. Finally, operational equivalence was tested with an expert group of both OR nurses and RNAs before being sent to the study participants [31].

Cronbach's alpha exceeded >0.77 for all factors. The closer this value is to 1.0, the greater the internal consistency (i.e., homogeneity) of the items in the instrument, indirectly indicating the degree to which a set of items measures a single one-dimensional latent construct [32]. Alpha values were similar across samples, ranging from 0.77 to 0.89 for the OR nurses and 0.79 to 0.88 for the RNAs.). The alpha values for the total PPCS-R. score was lower for these Swedish nurses (0.85) than for the OR nurses from Australia (0.96) [7] and Canada (0.97) [29]. The reason for this is unclear, but the inclusion of a new perioperative specialty (i.e. RNAs) in this study may have had an effect. High Cronbach alpha values can indicate redundant items. Alpha values also correlates with sample size and the number of items included in the instrument [32]. This study was explorative and no *a priori* power analysis was performed. When

calculating an approximated sample size with a narrow confidence interval and an alpha of 0.90 the estimation showed that 256 participants were considered sufficient [32]. However, to perform a CFA ten respondents per item is recommended [33]. In our study the sample size was just below 400 in each group (OR nurses: n= 395, RNAs: n=376). Our hypothesis was that the underlying construct of perioperative competence is the same for all nurses working in a perioperative context. According to the results of this study, construct validity and goodness-of-fit indices demonstrate acceptable, well-fitting models in both OR nurses and RNAs in Sweden. The Swedish version of the PPCS-R is a valid measure of perioperative competence in OR nurses and RNAs. This finding is also an indication of the internal construct validity of the PPCS-R. and confirms the original [7] six factor structure of the PPCS-R.

Inter-scale correlations between latent factors yielded good values in all factors in our model. At the item level, no item had an item-factor loading below the acceptable threshold of 0.3, but three items in the “proficiency” factor were only just above this threshold in both samples.

The construct validity analyzed with CFA showed an acceptable model fit : the SRMR, value was ≤ 0.06 , and the NFI was ≥ 0.95 [26]. This indicates that PPCS-R is suitable to use in both groups of professionals working as perioperative nurses in Sweden.

Strengths and limitations

The response rate was only 39 %, despite two follow up reminders. Two major and related reasons for falling response rates have been commonly identified: an increased difficulty in locating eligible participants and an increased likelihood that even if

potential participants are located and contacted, they will not be willing to participate[34]. However, Visser et al[35] . showed that some studies with low response rates, even as low as 20%, are able to yield more accurate results than studies with response rates of 60-70% [35]. More recent evaluations of national surveys by Holbrook *et al.*[36] (2007), with response rates ranging from 5% to 54%, have also concluded that studies with a low response rate were often only marginally less accurate than those with much higher response rates [36]. We contacted all participants (n=2902) with a registered email address in the membership database of the Swedish Association of Health Professionals. In retrospect, perhaps the response rate would have been higher if we had used both electronic and postal surveys [37]. The choice to use a web-based survey was mainly due to its cost-effectiveness [38]. The non-response included both unit-non response (*i.e.* a person not participating at all in the survey) and items non-response (*i.e.* a participant leaving at least one unanswered question on the survey)[37]. Another consideration is that many people now access the internet using their mobile phones [39]. Our survey was not modified to be suitable for a mobile phone screen, and this could have affected the response rate. The number of items in a survey is correlated with item non-response and lack of motivation, and so the shorter the survey, the better [37]. Another consideration is response bias, which is present if there is a relationship between the reason the responder did not answer and the questions asked[37]. We also acknowledge that selection bias may be present as we only invited nurses belonging to a professional association.

CONCLUSION

Psychometric testing of the Swedish translation of the PPCS-R. suggests a good construct validity and the construct and its six factors are conceptually relevant among the

Swedish OR nurses and RNAs. Self-assessment of competence offers RNA and OR nurses the opportunity for professional reflection and nurse educators to plan education strategies based on perioperative nurses' learning needs .

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