

**Psychometric Validation of the Perceived Perioperative  
Competence Scale-Revised in the Swedish Context**

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1 Title: Psychometric validation of the Perceived Perioperative Competence Scale-Revised  
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3 Running head: Psychometric testing of the Perceived Perioperative Competence scale-  
4 Revised

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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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66 **ABSTRACT**

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

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

71 **Design:** Cross- sectional survey.

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

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

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

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

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## 110 INTRODUCTION

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

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

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

134 communication, knowledge, technical skills, clinical reasoning, emotions, values and  
135 reflection in daily practice for the benefit of the individual and community being served”  
136 [12]. This definition is also applicable to advanced practice nurses such as registered  
137 nurse anesthetists (RNAs) and operating room (OR) nurses.

## 138 **Background**

### 139 *The literature review on competence instruments*

140 Several researchers agree that there is a lack of consensus in defining nurse competence  
141 [11-13]. This lack of consensus may be related to the differences in specialty and  
142 context, leading to the development and psychometric evaluation of instruments  
143 nuanced to different settings with participants of varying levels of clinical experience  
144 [4-6, 14]. Table 1 provides a summary of five tools developed to measure nurses  
145 ‘competence across various nursing samples and contexts. To date, the only instrument  
146 developed specifically for the perioperative context is the Perceived Perioperative  
147 Competence Scale- Revised (PPCS-R.)[7].

### 148 *The perioperative setting*

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



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

161

### 162 *The registered nurse anesthetists and the operating room nurse in Sweden*

163 The RNA is a perioperative nurse with nursing qualification who has undertaken  
164 additional education and specialty training in anesthesia. To become a RNA in Europe  
165 requires between one and four years of postgraduate education. After accreditation by  
166 an anesthesiologist the RNA independently induces, maintains and concludes general  
167 anesthesia. RNAs work in several countries, including Sweden, Norway, Denmark, the  
168 United States and Switzerland [20]. In addition to having nursing qualifications, the OR  
169 nurse has undergone additional postgraduate education in perioperative care, which  
170 takes from one to four years. OR nurses' duties encompass instrument and circulating  
171 roles. The role is based on the European Operating Room Nurses Association description  
172 of competence for perioperative nursing care, underpinned by the model of Tollerud *et*  
173 *al*[21] (1985). Both RNA and OR nurse roles encompass patient safety and advocacy [22,  
174 23].

175

### 176 **Aim**

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

180

## 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.

202

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

204 We used a two-phased approach in the translation and testing of the PPSC-R. In phase  
205 one, the PPSC-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 PPSC-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.

229

### 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].

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

- 255 a) *Standardized root mean square residual (SRMR)*: values lie between 0.0 and  
256 1.0, and 0.0 indicates perfect fit [26]
- 257 b) *Normed fit index(NFI)* : values lie between 0.0 and 1.0, with a cut-off of 0.95  
258 for a good model fit[26].
- 259 c) *Root mean square error of approximation (RMSEA)*: a value of around 0.06 or  
260 less indicates that the model fits the data closely, while values between 0.06  
261 and 0.08 indicate an acceptable fit [26].
- 262 d) *Item-factor loading*: values exceeding 0.30 are regarded as acceptable[27] and  
263 *T-values*  $\geq 2$  are considered to be significant ( $p < 0.0001$ ).

264 A maximum likelihood estimation method was used for the analysis. Since all the  
265 variables were ordinal, the polychoric correlation matrix of the observed variables  
266 was computed and applied in the analysis. The analysis was performed using version  
267 8.80 of the Linear Structural Relations (LISREL) software package [28].

268

## 269 **RESULTS**

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

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

### 278 **Internal consistency**

279 The six factors and 40 items of the translated version of the PPCS-R had Cronbach's  
280 alpha values of 0.77-0.89 for the OR nurses and 0.79-0.88 for the RNAs (Table 3).  
281 Cronbach's alpha for the total sample was  $\alpha$  0.85 while for RNAs and OR nurses, was  $\alpha$   
282 0.76

### 283 **Confirmatory factors analyses**

284 Before we proceeded with a CFA, an exploratory factor analysis (EFA) model was  
285 undertaken. The results from the EFA suggested that a six-factor model should be able to  
286 count the inter-correlations of the entire items. Two models were identified, one for OR  
287 nurses and the other for RNAs. The goodness-of-fit values were used to evaluate the  
288 internal construct validity for the OR nurses and RNAs. The p-values of chi-square tests  
289 for both groups were  $> 0.05$ , indicating that the six-factor model did not fit the data  
290 closely. The SRMR values: indicated good model fit for both groups (OR nurses: 0.067  
291 and RNA: 0.065). RMSEA values showed that the model fitted the data (OR nurses:  
292 0.065 and RNA: 0.061), and the NFI values in both groups lay within the range for a good  
293 model fit (OR nurses and RNA: 0.95).

294

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

299 “collegiality” and “skills and knowledge” in RNAs. The highest correlations were seen  
300 between “proficiency” and “skills and knowledge” in both groups.  
301 The factor structure of the responses was analysed. As shown in Table 6, no factor had a  
302 loading below the acceptable threshold of 0.3. Among the OR nurses items 21, 27 and 28  
303 had low item-factor loadings of 0.351, 0.306 and 0.386 respectively. All other items had  
304 factor loadings between 0.419 and 0.864. Among the RNAs, items 25, 27 and 29 had low  
305 item-factor loadings of 0.399, 0.309 and 0.379 respectively. All other items had item-  
306 factor loadings between 0.409 and 0.839. In two factors, OR nurses and RNAs had the  
307 highest factor loadings in the same item.  
308 The “collegiality” factor had highest factor loadings in the item “I tailor my  
309 communication based on a mix of personalities in the team” (OR nurses: 0.664, RNAs:  
310 0.617).The “empathy” factor had, highest factor loading in the item “I establish rapport  
311 with patients that enhances their ability to express feelings and concerns” (OR nurses:  
312 0.864, RNA: 0.545).  
313 In summary, the CFA results indicate an acceptable model fit for both groups and the  
314 factor loadings were all statistically significant.

315

316

## 317 **DISCUSSION**

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

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

327 The translation of the instrument was undertaken using a forward-translation method  
328 [24]. The goal was to have equivalence between the original and the Swedish version. In  
329 order to achieve equivalence in interpretation and conceptual meaning, three of the  
330 authors ( all Swedish researchers with experience of working as an OR nurse or RNA)  
331 discussed conceptual equivalence. Examination of item equivalence led to changes in  
332 two items in the PPCR-R in order to make it acceptable and appropriate for the target  
333 population and context. Finally, operational equivalence was tested with an expert  
334 group of both OR nurses and RNAs before being sent to the study participants [31].

335

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



347 calculating an approximated sample size with a narrow confidence interval and an alpha  
348 of 0.90 the estimation showed that 256 participants were considered sufficient [32].  
349 However, to perform a CFA ten respondents per item is recommended [33]. In our study  
350 the sample size was just below 400 in each group (OR nurses: n= 395, RNAs: n=376).  
351 Our hypothesis was that the underlying construct of perioperative competence is the  
352 same for all nurses working in a perioperative context. According to the results of this  
353 study, construct validity and goodness-of-fit indices demonstrate acceptable, well-fitting  
354 models in both OR nurses and RNAs in Sweden. The Swedish version of the PPCS-R is a  
355 valid measure of perioperative competence in OR nurses and RNAs. This finding is also  
356 an indication of the internal construct validity of the PPCS-R. and confirms the original  
357 [7] six factor structure of the PPCS-R.

358

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

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

366 Strengths and limitations

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

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

## 391 CONCLUSION

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

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

397

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