

## **RESEARCH PAPER**

Nurses emPOWERed for professional practice

The association between nursing work environment and quality of care: a cross-sectional study.

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Version:	Definitive
Date:	28 June 2018
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Internship institution:	Spaarne Gasthuis Hospital, Haarlem
Intended Journal:	Journal of Nursing Management
Reporting criteria:	STrengthening the Reporting of OBservational studies in Epidemiology (STROBE)
Reference style:	Vancouver
Word count:	3791
Word count English abstract:	300
Word count Dutch abstract:	300

## **ABSTRACT**

### **Background**

Due to societal and financial developments quality of care (QoC) is under pressure. QoC can be determined by patient outcomes and is, according to multiple studies, influenced majorly by nursing work environment. However, evidence is inconclusive. Also, variables to measure QoC vary widely, making it difficult to compare findings.

### **Aims**

To explore the association between nursing work environment and QoC, by (1) determining the association between nursing work environment and pain, malnutrition and readmissions, and (2) determining the association between pain, malnutrition and readmissions, and nurse-perceived quality of care (NPQoC).

### **Methods**

A quantitative cross-sectional study was conducted between January and March 2018 in a 400-bed Dutch tertiary teaching hospital. A hospital database and a survey containing the Practice Environment Scale of the Nursing Work Index instrument (PES-NWI), the 1-item indicator NPQoC, and nurse characteristics were used to collect data. Three multivariable logistic regression models were made with pain, malnutrition and readmission as dependent variables. Also, correlations were calculated between these variables and NPQoC.

### **Results**

Significant effects were found of nursing work environment on patient outcomes pain and malnutrition; units with better nursing work environment had 81% increase in the risk of moderate to severe pain, and 44% increase in the risk of moderate to severe malnutrition. Positive significant correlations were found between NPQoC and patient outcomes malnutrition and pain.

### **Conclusion and implication of key findings**

Due to wide variability of quality indicators measured in previous studies, it is difficult to compare current and previous findings. The 1-item indicator NPQoC could be appropriate to assess QoC. However, more comprehensive studies should be conducted to validate our results. Our study highlights the need for a joint international set of patient outcomes that are feasible to collect data and compare QoC.

### **Keywords**

Nursing, Quality of care, Patient safety, Practice environment

## **SAMENVATTING**

### **Achtergrond**

Maatschappelijke en financiële ontwikkelingen zetten de kwaliteit van zorg (QoC) onder druk. QoC kan worden bepaald met behulp van patiëntuitkomsten en wordt, volgens verschillende studies, grotendeels beïnvloed door de verpleegkundige werkomgeving. Bewijs voor dit verband is echter niet doorslaggevend. Daarnaast worden zeer variërende variabelen gebruikt om QoC te meten, wat vergelijking hiervan bemoeilijkt.

### **Doel**

De associatie tussen verpleegkundige werkomgeving en QoC exploreren, door (1) de associatie te bepalen tussen verpleegkundige werkomgeving en pijn, ondervoeding en heropname en (2) de associatie te bepalen tussen pijn, ondervoeding en heropnames, en door verpleegkundigen-ervaren kwaliteit van zorg (NPQoC).

### **Methode**

Een kwantitatieve cross-sectionele studie werd uitgevoerd tussen januari en maart 2018 in een Nederlands topklinisch ziekenhuis met 400 bedden. Een ziekenhuisdatabase en een vragenlijst met de Practice Environment Scale of the Nursing Work Index instrument (PES-NWI), de 1-item indicator NPQoC en kenmerken van verpleegkundigen, werden gebruikt om data te verzamelen. Drie multivariabele logistische regressiemodellen werden gemaakt met pijn, ondervoeding en heropname als afhankelijke variabelen. Tevens werden correlaties berekend tussen deze variabelen en NPQoC.

### **Resultaten**

Significante effecten werden gevonden van verpleegkundige werkomgeving op patiëntuitkomsten pijn en ondervoeding; afdelingen met een betere verpleegkundige werkomgeving hadden 81% meer kans op matig tot ernstige pijn en 44% meer kans op matig tot ernstige ondervoeding. NPQoC was significant positief gecorreleerd met patiëntuitkomsten ondervoeding en pijn.

### **Conclusie en implicatie van de bevindingen**

De variabiliteit van kwaliteitsindicatoren in eerdere studies bemoeilijkt het vergelijken van huidige en eerdere bevindingen. Eerdere studies suggereren significante associaties tussen verpleegkundige werkomgeving en QoC. De 1-item indicator NPQoC is mogelijk geschikt om QoC te beoordelen. Echter, meer onderzoek is nodig om deze resultaten te valideren. Deze studie toont het belang aan van een overeenkomstige, internationale set van patiëntuitkomsten, die geschikt is om te verzamelen en om QoC te vergelijken.

**Trefwoorden**

Verpleegkunde, Kwaliteit van zorg, Patiëntveiligheid, Praktijkomgeving

## INTRODUCTION

Due to societal developments such as aging, population growth, increasing chronic and complex diseases, but also due to evolving financial and quality regulations, the quality of care (QoC) is under pressure<sup>1,2</sup>. Given the fact that registered nurses (RNs) are the largest group of health care professionals in health care organizations and their direct contribution to patients' wellbeing, it is important to focus on the quality of nursing care<sup>3,4</sup>. Quality of nursing care can be influenced by multivariate factors: structural factors (e.g. staffing levels, RNs' educational levels or patients' diagnoses), outcome factors (e.g. health outcomes or nurse-perceived quality of care (NPQoC))<sup>5</sup>, and process factors (e.g. RNs' (inter)actions and perceptions that affect nursing care, also referred to as nursing work environment)<sup>4,6,7</sup>.

Dubois et al. (2017) identified nurse sensitive indicators for priority focus, such as pressure ulcers, medication errors, falls and hospital readmission<sup>8</sup>. However, in practice, these indicators are operationalized and measured in different ways, leading to difficulties in collecting and analyzing indicators from different organizations<sup>8</sup>. An indicator that is associated with various process and outcome measures is the 1-item indicator NPQoC<sup>9-11</sup>. NPQoC correlates significantly with outcome indicators such as survival after stroke or myocardial infarction<sup>9</sup> and with process indicators for pneumonia and surgical patients<sup>12</sup>. This indicator could possibly substitute multiple other indicators.

Growing body of evidence shows that patient outcomes are influenced majorly by nursing work environment, defined as "the organizational characteristics that facilitate or constrain professional nursing practice"<sup>13</sup>. Nursing work environment includes components such as foundations for QoC, nurse managers' and staffing characteristics and professional relationships<sup>14</sup>. While several systematic reviews conclude that there is a significant relationship between nursing working environment and patient outcomes, evidence for this relationship is inconclusive<sup>10,11</sup>. For instance, a favorable working environment is associated with lower mortality and failure to rescue rates and less patient falls<sup>7</sup>. On the other hand, mixed results were found for the association between nursing work environment and medication errors, nosocomial infections and nurse-reported patient safety<sup>7</sup>. As an example, one study found that a favorable working environment led to less medication errors<sup>17</sup>, while another found an association leading to more medication errors<sup>18</sup>, and yet another study did not find significant results at all<sup>19</sup>.

This study is part of the NPower research line (Nurses emPOWERed for professional practice) which focuses on the organization of nursing care<sup>20</sup>. Simultaneously, a cross sectional study was conducted on the relationship between nursing work environment and personnel outcomes<sup>21</sup>.

## **AIMS**

The aim was to explore the association between nursing work environment and QoC. Specifically, the following aims were addressed:

1. To determine the association between nursing work environment and QoC (measured by pain, malnutrition and hospital readmissions) in a Dutch hospital;
2. To determine the association between NPQoC, and patient outcomes pain, malnutrition and readmission.

## **METHODS**

This paper was conducted and reported according to the “STrengthening the Reporting of OBservational studies in Epidemiology (STROBE) checklist” for reporting observational cross-sectional studies<sup>22</sup>.

### **Design**

A quantitative cross-sectional study was conducted to determine the association between nursing work environment and QoC. This design is suitable to determine relationships between multiple dependent and independent variables, such as the occurrence of health outcomes, at one point in time<sup>23,24</sup>. A survey and a hospital database were used to measure concepts between January 2018 and March 2018. The structure-process-outcome framework of Donabedian was used to conduct this study<sup>5</sup>.

### **Population and setting**

The study was conducted in a 400-bed Dutch tertiary teaching hospital among four general units: the surgical, orthopedic, urologic/plastic surgical and gastrointestinal units. The sample consisted of RNs working on these units and patients admitted to these units from January 2018 till March 2018.

#### *RNs*

Purposive sampling was used to create a sample representative to RNs working on general units in Dutch hospitals. All RNs delivering direct patient care were identified by the nurse managers: licensed vocational nurses (LVNs), Bachelor Science nurses (BSNs), in-service nurses and nursing students. There was no function differentiation between LVNs and BSNs, meaning that all RNs had similar tasks and responsibilities. Nursing students worked on all units.

#### *Patients*

All patients admitted to the units were included via the Electronic Patient Records (EPR). No exclusion criteria were applied to achieve a sample representative to the true patient population.

### **Data collection**

#### *RNs*

Between January 2018 and March 2018 nurse managers were sent an e-mail with explanatory text and a link to the online survey (via [www.thesistoolspro.com](http://www.thesistoolspro.com)), which they

forwarded to RNs working on their unit. To maximize response rates reminders were sent and investigators visited the units to explain the need of the study.

### *Patients*

Variables were collected from the EPR and were delivered in an Excel sheet on patient level.

## **Measures**

### *RNs*

For RNs, variables were measured on structure, process and outcome levels, according to Donabedian's structure-process-outcomes framework<sup>5</sup> (figure 1). Structure consists of unit specialism and personnel characteristics (age, gender, working experience as a RN and educational level); process consists of the nursing work environment; outcome consists of NPQoC. Nursing work environment was used as independent variables in the models. Other personnel characteristics were used for descriptive statistics.

### *Insert figure 1*

The survey consisted of (1) the Practice Environment Scale of the Nursing Work Index instrument (PES-NWI), (2) the 1-item indicator NPQoC, and (3) the following personnel characteristics: age (years), gender, working experience as a RN (years), educational level (LVN, in-service, BSN, scientific education or nurse specialization) and unit specialism. The PES-NWI is a commonly used instrument to measure nursing work environment<sup>7</sup>. It has adequate construct validity and reliability (Cronbach's alpha 0.95)<sup>25</sup> and is a low burden for RNs<sup>26,27</sup>. It measures factors that affect RNs' ability to deliver high quality care based on 31 items on five subscales: Nurse Participation in Hospital Affairs; Nursing Foundations for QoC; Nurse Managers' Ability, Leadership and Support; Staffing and Resource Adequacy; and Nurse-Physician Relationships. Items are scored on a four-point Likert scale ranging from 1 (strongly disagree) to 4 (strongly agree). Mean subscale scores and a composite total score are calculated. A score of  $\geq 2.5$  means that RNs are positive about a subscale or perceive their work environment as favorable<sup>13</sup>. The frequently used 1-item indicator NPQoC is associated with several RN and patient outcomes. It is scored on a four-point Likert scale ranging from 1 (poor) to 4 (excellent)<sup>12</sup>.

### *Patients*

For patients, variables measured on the outcomes level were used as dependent variables in the models: pain, malnutrition and readmissions. Additionally, characteristics that are addressed to be predictive for the occurrence of various patient outcomes, were retrieved



from EPRs and used as independent variables in the models: age (years), gender, admission type (elective or emergent), and unit specialism (figure 1)<sup>28</sup>.

All patient outcomes were measured dichotomously. Pain was measured using the Numeric Rating Scale (NRS) (weighted Kappa 0.63)<sup>29</sup>. Using an 11-point numeric scale, patients express their pain from 0 (no pain) to 10 (worst pain imaginable). The following cut off points reflect the pain intensity: <4 (no to mild pain),  $\geq 4-6$  (moderate pain),  $\geq 7$  (severe pain)<sup>30</sup>. In this study, pain was dichotomized into no to mild pain (NRS<4) and moderate to severe pain (NRS $\geq 4$ ). Average pain scores during admission were calculated, because average pain is more stable and better reflects the interference with daily activities than worst pain does<sup>30,31</sup>. Malnutrition was measured using the Short Nutritional Assessment Questionnaire (SNAQ). This 4-item screening tool determines patients' (risk for) malnutrition, based on weight loss, appetite loss and supplemental drinks or tube feeding (Kappa 0.69 for nurse-nurse reproducibility and 0.91 for nurse-dietician reproducibility)<sup>32</sup>. The score ranges from 0 to 5, with the following cut-off points:  $\leq 1$  (no malnutrition), 2 (moderate malnutrition),  $\geq 3$  (severe malnutrition)<sup>32</sup>. In this study malnutrition was dichotomized into no to mild malnutrition (SNAQ<2) and moderate to severe malnutrition (SNAQ $\geq 2$ ). Readmissions were measured as the occurrence or non-occurrence of unplanned readmissions within 30 days after discharge.

### **Data analysis**

Data were analyzed using IBM SPSS Statistics for Windows version 23.0<sup>33,34</sup>. Categorical data were presented as proportions. Continuous data were summarized as medians with interquartile range (IQR) and range.

A dataset was created on patient level. For all personnel variables aggregated values (medians or proportions) were calculated per unit. For nursing work environment, the median composite score was calculated per unit. Then, using the median composite score for the total dataset, nursing work environment was divided into two groups by median split: 'lower-perceived nursing work environment' and 'higher-perceived nursing work environment'. To determine whether these groups differed by RNs age, gender, educational level, working experience and PES-NWI scores, Fisher's exact tests were used for categorical data and Mann-Whitney U tests were used for continuous data.  $p \leq 0.05$  was considered as statistically significant.

Assumptions for logistic regression were tested<sup>34</sup>. Three prediction models were made with pain, malnutrition and readmissions as dependent, binary variables. Also, correlations were calculated between these outcomes and NPQoC as polytomous variable. For each analysis,

available case analyses were performed, which is appropriate to produce unbiased estimates in datasets with values missing completely at random (MCAR)<sup>35</sup>. First, univariable analyses were conducted. Variables with a significance level of  $p \leq 0.200$  were entered into a multivariable logistic regression model, using the stepwise backwards method. Stepwise backwards selection was used to prevent exclusion of variables due to their involvement in suppressor effects, causing type II errors<sup>36</sup>. In cases of multicollinearity, least significant variables were removed from the model. Using Likelihood Ratio tests variables were removed until there were no non-significant variables in the model. A significance level of  $p < 0.05$  was set. Results were presented as odds ratios with 95% confidence intervals<sup>34</sup>.

### *Missing data*

Because no sensitive topics were collected and patient outcomes were mandatory to be collected for all patients, it was not expected that data was missing due to the nature of these or other variables. Therefore, missing data was considered as MCAR<sup>35</sup>.

### **Ethical issues**

The Local Regularities Committee of the participating hospital approved the study but waived the need for ethical approval by a Medical Ethics Committee. This study is not covered under the Act Medical Research Involving Human Subjects, because patients and RNs did not undergo study specific actions. The study was performed following the principles of the Declaration of Helsinki<sup>37</sup> and the privacy law for data-collection, processing and publication. There were no conflicts of interest and no undesirable outcomes were anticipated. A possible benefit is contribution to effective nursing work environments and improved health outcomes for future patients.

## RESULTS

### Participants

#### *RNs' demographics*

The survey was sent to 153 RNs, response rate was 74 (48.4%). RNs worked mostly on the gastrointestinal (29.7%) and surgical (28.4%) units. Median age was 26 years (IQR 24) and majority was female (91.9%). Most RNs were LVN-educated (53.4%) with a median working experience of 11 years (IQR 22). Missing values were found for age (4.1%), educational level (1.4%) and working experience (12.2%) (table 1).

#### *Patients' demographics*

Data were collected for 2284 patients. Most patients were admitted to the surgical (32.3%) unit. Mean age was 68 years (IQR 21) and majority (66.5%) of patients was female. Missing values were found for pain (2.8%) and malnutrition (11.6%). (table 1).

*Insert table 1.*

### Findings

Independent variables included in the logistic regression models were nursing work environment, patients' age and gender and admission type. Unit specialism was not included in the models due to multicollinearity, personnel characteristics were not included in the models due to no variation within the aggregated personnel characteristics per unit. Dependent variables were pain, malnutrition and readmission.

Nursing work environment was analyzed based on composite PES-NWI scores (N=59). The median composite score was 2.75 (IQR 0.20). Using median split, nursing work environment was categorized into two groups: 'lower-perceived nursing work environment' and 'higher-perceived nursing work environment'. This led to categorization of the surgical and orthopedic units in 'lower-perceived nursing work environment' (composite scores 2.73 and 2.64, respectively), and the urology/plastic surgical and gastrointestinal units in 'higher-perceived nursing work environment' (composite scores 2.77 and 2.81, respectively) (figure 2).

*Insert figure 2.*

The two groups ('higher-perceived nursing work environment' and 'lower-perceived nursing work environment') did not differ statistically for RNs' gender, age, educational level and working experience. Differences between the groups were found for the PES-NWI composite

score ( $p=0.035$ ) and the PES-NWI subscale Nurse-Physician Relationship ( $p=0.000$ ) (table 2). The group with 'higher-perceived nursing work environment', consisting of the urology/plastic surgical units, significantly perceived the nursing work environment as more favorable and was more positive about the relationship between nurses and physicians, as compared to the surgical and orthopedic units.

*Insert table 2.*

### *Pain*

2220 complete cases (97.2% of all patients) were included in the model for pain. Nursing work environment was significantly associated with pain in the multivariable model. Patients admitted to units with 'higher-perceived nursing work environment' had an 81% increased risk of experiencing moderate to severe pain as compared to patients admitted to units with 'lower-perceived nursing work environment' (OR 1.81; 95% CI [1.10-3.00];  $p=0.022$ ). Variables that were also significant in the multivariable model were patients' age and admission type ( $p\leq 0.004$ ). An increase in patients' age of 1 year was associated with a 3% decrease in the risk of moderate to severe pain. Patients admitted to the hospital emergently had 67% increased risk of experiencing moderate to severe pain, compared to patients admitted electively. The final multivariable model explained 5.6% (Nagelkerke R Square) of the total variance for pain (table 3).

### *Malnutrition*

2018 complete cases (88.4% of all patients) were included in the model for malnutrition. A significant association between nursing work environment and malnutrition was found in the multivariable analyses. Patients admitted to units with 'higher-perceived nursing work environment' had 44% increased risk of moderate to severe malnutrition, compared to patients on units with 'lower-perceived nursing work environment' (OR 1.44; 95% CI [1.001-2.08];  $p=0.049$ ). Other variables that were significantly associated in the multivariable model were patients' age and admission type ( $p\leq 0.000$ ). Age increased the risk of moderate to severe malnutrition with 2% for each year. a 230% increased risk of moderate to severe malnutrition was caused by emergent admissions (table 3). The final model explained 9.7% (Nagelkerke R Square) of the total variance for malnutrition.

### *Hospital readmissions*

2284 complete cases (i.e. all patients) were included in the model for readmission. No significant association was found between nursing work environment and readmission in the multivariable model (OR 0.76; 95% CI [0.51-1.13];  $p=0.178$ ). Variables that were significant

in the multivariable model were patients' gender and admission type ( $p \leq 0.000$ ). Male patients had 94% increased risk of readmissions compared to female patients. Emergently admitted patients had 225% more risk of readmission than electively admitted patients. The model explained 9.6% (Nagelkerke R Square) of the total variance for readmission. In the univariable model, nursing work environment, patients' age, gender and admission type were all significant ( $p \leq 0.027$ ) (table 3).

*Insert table 3.*

#### *Nurse-perceived QoC*

NPQoC correlated significantly positive ( $p \leq 0.000$ ) with malnutrition and readmission ( $r=0.142$  and  $r=0.243$  respectively). This means that higher NPQoC was associated with more severe malnutrition and higher readmission rates. No significant correlation was found between NPQoC and pain ( $p=0.073$ ) (table 4).

*Insert table 4.*

## DISCUSSION

Patients who were admitted to units with a 'higher-perceived nursing work environment' had a 81% increased risk of moderate to severe pain and a 44% increased risk of moderate to severe malnutrition, compared to patients admitted to units with a 'lower-perceived nursing work environment'. No significant association was found between nursing work environment on readmission. Positive significant correlations were found between quantitative indicators pain and malnutrition and the qualitative 1-item indicator NPQoC.

It is noticeable that a better perceived nursing work environment led to worse patient outcomes, and this finding is in contrast to existing evidence. Regarding pain, our significant positive finding is contradictory to the limited evidence from previous studies, which did not find significant results. One descriptive study was found, measuring nurses' use of evidence-based pain management (e.g. performing frequent pain (re-)assessments with reliable and valid instruments, and assessment-based interventions) as an alternative to patient-reported pain<sup>38</sup>. The study population and used instruments were relatively similar to our study: the population consisted of 85 RNs working on three surgical units of metropolitan teaching hospitals and the PES-NWI was used to measure nursing work environment. Even though the study showed no significant associations between nursing work environment and the use of evidence-based pain management, patient-perceived pain was not measured and the findings are not completely comparable. As for malnutrition, no previous studies were found examining the association between nursing work environment and malnutrition or surrogate measures<sup>16</sup>. Therefore we could not compare our significant positive finding to existing evidence. Regarding readmission, while we did not find significant associations between nursing work environment and readmission in the multivariable model, a significant association was found in the univariable model. The non-significant finding in the multivariable model could be due to little variation in the variable 'nursing work environment', which consisted of only two categories in our analyses. A systematic review of these concepts found significant associations between better nursing work environment and lower readmission rates in seven of ten studies<sup>39</sup>. However, only one of these studies measured nursing work environment using the PES-NWI, while other studies used various other measurements, e.g. nurse staffing levels and nursing hours per patient day. Although the study using the PES-NWI included 324,042 patients from 412 hospitals, and showed that hospitals with a better nursing work environment had 7% to 10% lower odds of readmission, the population may not be generalizable to our population, since the study focused on patients with heart failure, myocardial infarction and pneumonia<sup>40</sup>.

It is noticeable that limited research has been performed on the effect of nursing work environment on our outcome measures. Malnutrition, for instance, is associated with many adverse outcomes such as decreased wound healing, muscle wasting and even mortality, indicating its relevance for clinical practice<sup>41</sup>.

Although little research has been conducted on our outcome measures, more extensive research on other measures for QoC has been conducted. For example, a recent systematic review of Wei et al. (2018) showed that a healthy nursing work environment was significantly associated with fewer cases of failure to rescue, 30-day and in-hospital mortality, and pressure ulcers<sup>42</sup>. Another systematic review on nursing work environment (measured by the PES-NWI or the Nursing Work Index Revised (NWI-R)) and NPQoC found positive significant associations between nursing work environment and NPQoC in seven out of ten studies<sup>14</sup>. However, the many different patient outcomes that are used make it difficult to compare findings.

Finally, although positive correlations we found between NPQoC and patient outcomes pain and malnutrition were weak, the evidence is supported by a previous study that found strong correlations. This study, conducted in six non-universal Dutch hospitals, showed a strong positive correlation between NPQoC and a composite score for three indicators (screening of delirium, malnutrition and pain) ( $r=0.943$ )<sup>10</sup>. This indicates that the 1-item indicator NPQoC could be an appropriate indicator to measure QoC. Benefits of this indicator are, for instance, that measurement is easy and inexpensive, a low burden for RNs, feasible for all organizations and appropriate for comparison.

### **Strengths and limitations**

Health care organizations are complex systems in which the relationship between structure, process and outcomes depend on a multiplicity of variables. Many studies measured nursing work environment on the structural level, e.g. nurse staffing levels and skill mix. By using Donabedian's framework and measuring nursing work environment on the process level, a multivariate systemic approach was used, assessing relationships from different levels.

There were some limitations in this study. Firstly, nurse middle managers from six units were approached to participate in the study. Unfortunately, the nurse middle manager from both the internal medicine and oncological units was not willing to participate in suitable timelines and these units were excluded. Selection bias could have occurred due to this exclusion, since nurse managers' leadership, management and support play an important role in perceived nursing work environment and patient outcomes<sup>14,43</sup>. Due to the small sample of 74 nurses from one Dutch hospital, results can not be generalized. For example, the median

composite PES-NWI score for all RNs was 2.75 (ranging from 1.75 to 2.81 between units), which is slightly higher than the mean PES-NWI score (2.63) for hospitals in the Netherlands<sup>44</sup>. The two groups ('lower-perceived nursing work environment' and 'higher-perceived nursing work environment') differed only by the PES-NWI composite score and one PES-NWI subscale (Nurse-Physician Relationships), but were similar for all other characteristics that were measured.

A second limitation is that aggregated personnel characteristics were calculated per unit, to merge patients' data and personnel data based on unit specialism. Hence, aggregated personnel variables (e.g. median age per unit) showed no variation within a unit, and these variables were not entered in the models. This lack of individual data may have negatively affected the precision and accuracy of data.

Lastly, the wide variety of patient outcomes that are used in studies and clinical practice to measure QoC, makes it difficult to compare current and previous findings. This is also addressed by Dubois et al. (2017), who recommend several priority indicators to use when measuring QoC (e.g. pressure ulcers, medication errors, falls and readmission). In our study we intended to use Dubois' priority indicators. However, of these indicators, readmission was the only outcome that was feasible to collect in the participating hospital. Other outcomes were selected based on feasibility. This issue points out the lack of standardized and usable outcome measures reported by hospitals.

### **Implications for clinical practice and future research**

Results of this study highlight the need for a standardized, (inter-)national set of patient outcomes that is feasible to collect and suitable to compare QoC. Governments (e.g. in the United States, Netherlands, Denmark and United Kingdom) mandate the measurement of various process indicators, such as screening for malnutrition or pressure ulcers<sup>45</sup>. Though, the actual outcome indicators are often omitted and their availability is insufficient<sup>46,47</sup>. Having insight in QoC is of great importance for many parties, for instance health care organizations, policy makers, governments and health insurances. To gain more insight in QoC, the focus should be more on outcome indicators, such as the occurrence of malnutrition or pain. Not only should these indicators be measured and reported in like manner for comparability, but also they should be reported more insightfully. After all, sufficient insight in data is necessary to use the indicators adequately (e.g. to examine causal relationships). A first step could be to report outcomes on individual patient level instead of using period or point prevalence.

### **Conclusions**

Our results indicate that, remarkably, a higher-perceived nursing work environment increases the risk of more severe pain and malnutrition. NPQoC could be an appropriate 1-item



indicator to measure QoC. However, we did not find strong evidence for these associations and more research should be done to support our findings. To gain more insight in QoC and factors affecting QoC, it is of great importance to create a standardized set of outcome indicators to be measured in clinical practice and to report these indicators more insightfully.

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## TABLES AND FIGURES

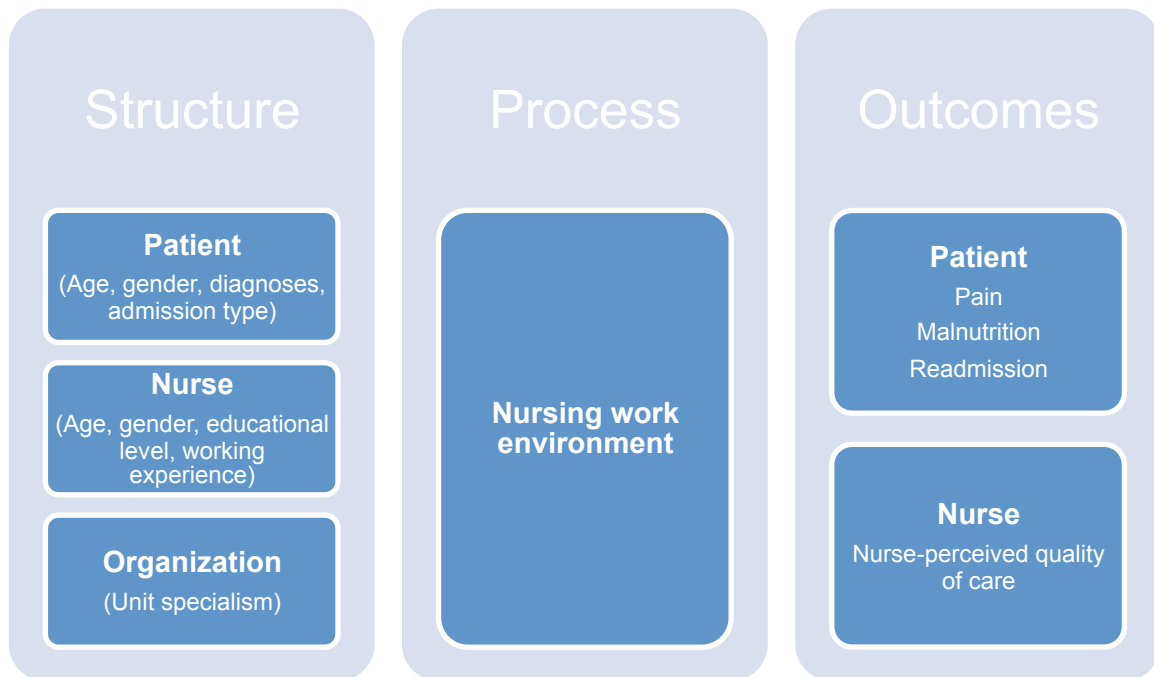


Figure 1. Donabedian's structure-process-outcomes framework adjusted to this study

Table 1. Personnel and patient characteristics

Personnel characteristics (N=74)	N (%)	Median (IQR)	Range
<b>Personnel characteristics (N=74)</b>			
Unit			
Surgery	21 (28.4%)		
Orthopedics	19 (25.7%)		
Urology / plastic surgery	12 (16.2%)		
Gastrointestinal	22 (29.7%)		
Gender			
Female	68 (91.9%)		
Male	6 (8.1%)		
Age (N=71)		26.0 (24.0)	21-63
Educational level (N=73)			
Licensed vocational	39 (53.4%)		
In-service	15 (20.5%)		
Higher-level	15 (20.5%)		
Specialization	4 (5.5%)		
Scientific	0 (0%)		
Working experience (N=65)		11.0 (22.0)	1-43
Shift type (N=69)			
Day	34 (49.3%)		
Evening	22 (31.9%)		
Night	13 (18.8%)		
Nursing work environment (N=59)			
Low perceived (<2.7509)	12 (16.2%)		
High perceived (≥2.7510)	62 (83.8%)		
Number of patients to care for		7.0 (5.0)	0-17
Number of patients to care for			
Less than usual	12 (17.1%)		
Same as usual	51 (72.9%)		
More than usual	7 (10.0%)		
Number of nurses during shift		4.0 (3.0)	1-10
Number of BSNs during shift		1.0 (1.0)	0-9
Number of other caregivers during shift		2.0 (3.0)	0-7
<b>Patient characteristics (N=2284)</b>			
Unit			
Surgery	738 (32.3%)		
Urology / plastic surgery	398 (17.4%)		
Orthopedics	613 (26.8%)		
Gastrointestinal	535 (23.4%)		
Gender			
Female	1520 (66.5%)		
Male	764 (33.5%)		
Age (N=2279)		68.0 (21.0)	18 - 105
Admission type			
Elective	1704 (74.6%)		
Emergency	580 (25.4%)		
Length of hospital stay (N=2279)		2.00 (3.00)	0 - 57
Nursing work environment			
Low perceived (<2.7509)	398 (17.4%)		
High perceived (≥2.7510)	1886 (82.6%)		

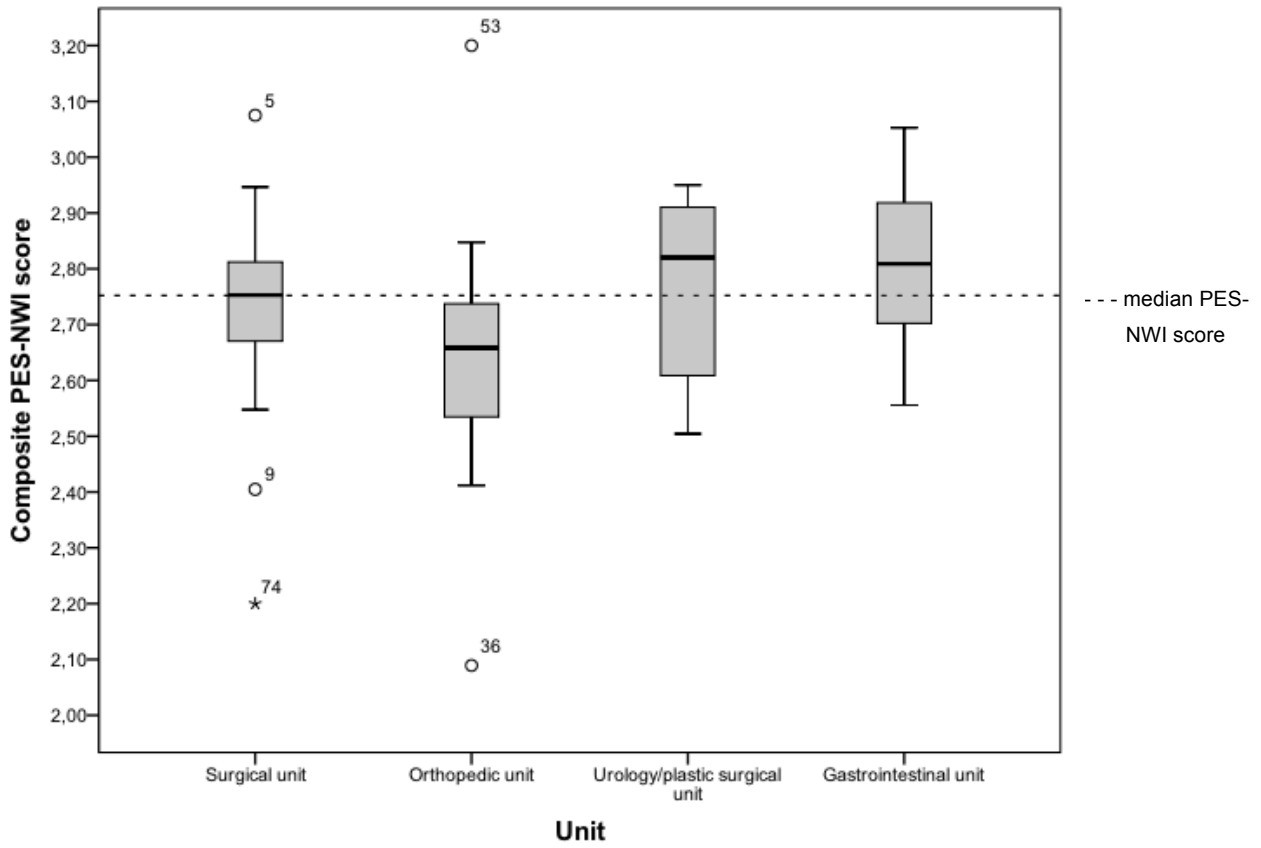


Figure 2. Distribution of PES-NWI scores per unit



Table 2. Registered nurses' characteristics per unit and per group

	Surgery	Orthopedics	Urology/ Plastic surgery	Gastrointestinal	Lower-perceived nursing work environment <sup>c</sup>	Higher-perceived nursing work environment <sup>d</sup>	p-value
Gender (female) <sup>a</sup>	18 (85.7%)	19 (100%)	10 (83.3%)	21 (95.5%)	37 (92.5%)	31 (91.2%)	1.000
Educational level <sup>a</sup>							
Licensed vocational	5 (23.8%)	13 (68.4%)	9 (75.0%)	12 (54.5%)	18 (46.2%)	17 (56.7%)	
In-service	3 (24.3%)	5 (26.3%)	2 (16.7%)	5 (22.7%)	8 (20.5%)	7 (23.3%)	0.459
Higher-level	9 (42.9%)	1 (5.3%)	0 (0.0%)	5 (22.7%)	10 (25.6%)	5 (16.7%)	
Specialization	3 (14.3%)	0 (0.0%)	1 (8.3%)	0 (0.0%)	3 (7.7%)	1 (3.3%)	
Scientific	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	
Age <sup>b</sup>	33.5 (23)	35.0 (26)	42.0 (21)	42.0 (28)	34.0 (25)	42.0 (25)	0.760
Work experience <sup>b</sup>	12.0 (23)	7.0 (13)	16.5 (24)	9.5 (23)	12.0 (21)	10.5 (24)	0.969
PES-NWI (sub-)scores <sup>b</sup>							
Composite score	1.75 (0.16)	2.65 (0.31)	2.72 (0.39)	2.81 (0.24)	2.75 (0.15)	2.80 (0.42)	<b>0.035</b>
Staffing and Resource Adequacy	2.50 (0.75)	2.25 (0.25)	2.50 (0.50)	2.63 (0.94)	2.25 (0.75)	2.63 (0.56)	0.053
Nurse-Physicia Relationships	2.86 (0.18)	2.86 (0.43)	3.00 (0.36)	3.00 (0.00)	2.86 (0.21)	3.00 (0.36)	<b>0.000</b>
Nurse Managers' Ability, Leadership and Support	3.00 (0.25)	3.00 (0.25)	3.00 (0.44)	3.00 (0.25)	3.00 (0.50)	3.00 (0.25)	0.427
Nursing Foundations for QoC	2.89 (0.33)	2.78 (0.44)	2.89 (0.29)	2.83 (0.11)	2.89 (0.33)	2.89 (0.24)	0.208
Participation in Hospital Affairs	2.56 (0.53)	2.50 (0.25)	2.25 (0.81)	2.50 (0.34)	2.50 (0.41)	2.50 (0.25)	0.773

<sup>a</sup> reported as N (%), p-value is shown for Fisher's Exact tests

<sup>b</sup> reported as median (IQR), p-value is shown for Mann-Whitney U tests

<sup>c</sup> surgical and orthopedic units

<sup>d</sup> urological/plastic and gastrointestinal surgical units

Table 3. Odds ratios for the logistic regression models of pain, malnutrition and readmission

Pain (N=2220)								
	No to mild malnutrition		Moderate to severe malnutrition		Univariable model		Multivariable model	
	Median (IQR)	N (%)	Median (IQR)	N (%)	OR (CI 95%)	p-value	OR (CI 95%)	p-value
Patient's age	69.0 (20)		61.5 (25)		0.97 (0.97-0.98)	0.000	0.97 (0.97-0.98)	<b>0.000</b>
Patient's Gender	Female	1348 (66.2%)	134 (73.2%)		<i>RC</i>			
	Male	689 (33.8%)	49 (26.8%)		0.72 (0.51-1.01)	0.053	0.72 (0.49-1.04)	0.080
Admission type	Elective	1535 (75.4%)	126 (68.9%)		<i>RC</i>			
	Emergency	502 (24.6%)	57 (31.1%)		1.38 (1.00-1.92)	0.053	1.67 (1.17-2.38)	<b>0.004</b>
PES-NWI score	Low (<2.7509)	364 (17.9%)	19 (10.4%)		<i>RC</i>			
	High (>2.7510)	1673 (82.1%)	164 (89.6%)		1.88 (1.15-3.06)	0.011	1.81 (1.10-3.00)	<b>0.022</b>

Malnutrition (N=2018)								
	No to mild malnutrition		Moderate to severe malnutrition		Univariable model		Multivariable model	
	Median (IQR)	N (%)	Median (IQR)	N (%)	OR (CI 95%)	p-value	OR (CI 95%)	p-value
Patient's age	68.0 (21)		73.0 (20)		1.02 (1.01-1.03)	0.000	1.02 (1.01-1.03)	<b>0.000</b>
Patient's Gender	Female	1156 (68.3%)	209 (64.15%)		<i>RC</i>			
	Male	536 (31.7%)	117 (35.9%)		1.21 (0.94-1.55)	0.137		
Admission type	Elective	1342 (79.3%)	175 (53.7%)		<i>RC</i>			
	Emergency	350 (20.7%)	151 (46.3%)		3.31 (2.58-4.24)	0.000	3.30 (2.57-4.24)	<b>0.000</b>
PES-NWI score	Low (<2.7509)	263 (15.5%)	41 (12.6%)		<i>RC</i>			
	High (>2.7510)	1429 (84.5%)	285 (87.4%)		1.28 (0.90-1.82)	0.171	1.44 (1.001-2.08)	<b>0.049</b>

OR=odds ratio CI=confidence interval RC=reference category

Table 3 continued

Readmission (N=2284)								
	No readmission		Readmission		Univariable model		Multivariable model	
	Median (IQR)	N (%)	Median (IQR)	N (%)	OR (CI 95%)	p-value	OR (CI 95%)	p-value
Patient's age	68.0 (22)		72.0 (21)		1.01 (1.00-1.02)	0.027	1.01 (1.00-1.02)	0.051
Patient's Gender	Female	1454 (68.2%)		66 (43.1%)	RC			
	Male	677 (31.8%)		87 (56.9%)	2.83 (2.03-3.95)	0.000	1.94 (1.35-2.78)	<b>0.000</b>
Admission type	Elective	1635 (76.7%)		69 (45.1%)	RC			
	Emergency	496 (23.3%)		84 (54.9%)	4.01 (2.87-5.60)	0.000	3.25 (2.29-4.60)	<b>0.000</b>
PES-NWI score	Low (<2.7509)	358 (16.8%)		40 (26.1%)	RC			
	High (>2.7510)	1773 (83.2%)		113 (73.9%)	0.57 (0.39-0.83)	0.004	0.76 (0.51-1.13)	0.178

OR=odds ratio CI=confidence interval RC=reference category

Table 4. Correlations between nurse-perceived QoC and patient outcomes

	Nurse-perceived quality of care		
	N	Pearson's r	p-value
<b>Pain</b>	2220	0.038	0.073
<b>Malnutrition</b>	2018	0.142	<b>0.000</b>
<b>Readmission</b>	2284	0.243	<b>0.000</b>