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AN OBSERVATIONAL STUDY TO IDENTIFY ORGANIZATIONAL PROCESSES ASSOCIATED WITH NURSE-REPORTED QUALITY AND PATIENT SAFETY

Journal:	*BMJ Open*
Manuscript ID:	bmjopen-2012-001967
Article Type:	Research
Date Submitted by the Author:	16-Aug-2012
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Primary Subject Heading:	Health services research
Secondary Subject Heading:	Health services research
Keywords:	Organisation of health services < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Quality in health care < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Health & safety < HEALTH SERVICES ADMINISTRATION & MANAGEMENT

Title:

AN OBSERVATIONAL STUDY TO IDENTIFY ORGANIZATIONAL PROCESSES ASSOCIATED WITH NURSE-REPORTED QUALITY AND PATIENT SAFETY

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Key-words:

Patient safety, performance measures, nurses, survey, quality measurement.

Word count: 3202

ABSTRACT

Objectives: Health care workers' attitudes and perceptions related to patient safety vary by disciplines within the health care organisations, and nurses constitute a large proportion of health care workers. To target patient safety interventions it is vital to understand how nurses as a microsystem assess organisational structures and processes and relate them to patient safety.

Design: The present study is an observational cross-sectional study

Setting: The multicenter study is conducted in 35 Norwegian hospitals with more than 85 beds.

Participants: All registered nurses working in direct patient care in a position of 20% or more were invited to answer a survey. Through the questionnaire organizational processes were measured by the *Nursing Work Index Revised* and items from *Hospital Survey on Patient Safety Culture.* Organizational structure measures were also included as explanatory variables in the analyses.

Outcome measures: Nurses' assessments of patient safety, quality of nursing, how they believe their patients manage after discharge and frequency of adverse events were used as outcome measures.

Results

Active programs to ensure quality, hospital management that encourage patient safety and having sufficient staff to provide quality of care were consistently related to how nurses perceive both work- and patient related outcome measures. Nurse physician relationship and working in a regional hospital gave higher ratings for work-related outcomes. Bed occupancy and nurse-patient ratio was positively associated with how nurses assessed patient related outcomes.

Conclusion

Organisational structures may have impact on how nurses perceive work- and patient related outcomes, but the findings in this study indicate that there is a considerable potential to address organisational design to improve of nurses' assessments of patient safety.

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Introduction

The report "Crossing the quality chasm" from the Institute of medicine in 2001 called for a system change to improve safety in the health care services[1]. The report led to the establishment of patient safety programmes and health care reforms in many Western countries. The introduction of evidence-based practice, guidelines, performance measurements, and feedback has characterized patient safety initiatives in hospitals during the last decade. However, results from evaluations of these efforts are inconsistent, and several authors have described a need to better understand how organizational features contribute to quality and patient safety in hospitals[2-4].

The underlying hypothesis of Donabedian's model for quality is that hospital structures and processes contribute to health care outcomes. There is a growing body of evidence on associations between organizational features and healthcare performance. Physicians' work environment has been associated with the quality of health service delivery, and improvement of nurses' work environment could be a cost effective strategy to improve patient outcomes[5-8]. Work environment for nurses has been associated with patient outcomes such as risk-adjusted mortality and patient satisfaction [9-11]. Organizational structures such as hospital size and staff ratios have also been related to patient safety outcomes, but knowledge about how to control for organisational structures when evaluating patient safety and quality interventions is sparse[4,12].

The inertia of organisational change observed in health care institutions may be explained by an inherence of values and traditions among health care workers that restrain the capacity for

transformation[3]. Attitudes and perceptions related to patient safety vary by disciplines and microsystems, and the planning and implementation of strategies and interventions to improve patient safety should take such variations into account[13-17]. Information about how individuals within the microsystems perceive and take advantage of structures and processes in the organization is vital for the design of patient safe health care institutions[16,18,19]. Donabedian's recognized approach to explore what is important in modern health care planning serves as framework for this study. Nurses constitute a large proportion of health care workers, and how they perceive an organizational design promoting patient safety may provide essential information about nurses as a microsystem[4,20]. In the present investigation we study how nurses assess organisational features and relate them to patient safety and quality of nursing.

Methods

Design and data collection

This observational cross-sectional study involves a survey among nurses in surgical and medical wards in 35 Norwegian hospitals with more than 85 beds. The data collection was part of the European RN4Cast study[21]. A paper questionnaire, information letter, and return envelope were distributed through the nurses' union representatives to 6600 nurses during the autumn of 2009. Registered nurses working in direct patient care in a position of 20% or more were included, and nurses on long-term leaves were excluded. Nurses received the questionnaire at their workplaces, and no personal reminders were distributed. The method of data collection and handling was approved by the Data Protection Official for Research.

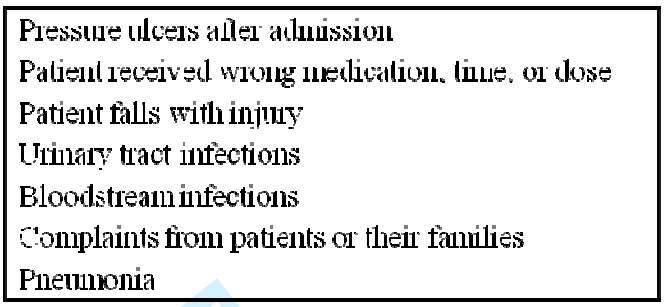
Nurse-reported outcome measures

The dependent variables were based on nurses' responses to global questions about quality of nursing and patient safety from the questionnaire. The outcomes were divided into two groups of which "work-related" refers to how nurses assess work performance and "patient-related" refers to nurses' assessments of patient outcomes:

- Work-related outcome measures
  - Quality of nursing: In general, how would you describe the quality of nursing care delivered to patients on your unit/ward? (four-point Likert-type scale where 1=poor, 2=fair, 3=good, and 5=excellent)
  - Patient safety: Please give your department an overall grade on patient safety. (5-point Likert-type scale where 1=failing, 2=poor, 3=acceptable, 4=very good, and 5=excellent)
- Patient-related outcome measures
  - Self-care ability: How confident are you that your patients are able to manage their care when discharged? (four-point Likert-type scale where 1=not at all confident, 2=somewhat confident, 3=confident, and 4=very confident)
  - Absence of adverse events: Nurses were also asked to estimate how frequently adverse events have happened to their patients on a seven-point Likert-type scale (1=every day, 2=some times per week, 3=once a week, 4=some times per month, 5=once a month or less, 6=some times per year, 7=never).

In the present study the different types of adverse events in question are summarized in a composite score for absence of nurse-reported adverse events (figure 1).

Figure 1. Types of adverse events assessed by nurses and merged in the composite score "absence of adverse events"



Organizational process measures

The nurses' work environment was measured by the practice environment scale of the *nursing work index revised* (PES-NWI). The instrument has been tested in different cultural contexts, and the Norwegian version of the PES-NWI has been translated and tested according to acknowledged procedures for questionnaire modifications between cultures. We performed an exploratory analysis to identify the factor structure of the Norwegian dataset. The subscales identified were used as explanatory variables in the study. The items were four-point Likert-type scales where 1=strongly disagree, 2=somewhat disagree, 3=somewhat agree, and 4=strongly agree.

In addition to the questions from PES-NWI, we used three items included in the questionnaire *Hospital Survey on Patient Safety Culture* (HSOPSC) developed by The Agency for Healthcare Research and Quality[22]. The items represent leadership topics such as performance feedback and actions showing that patient safety has priority in hospital management. The items were aggregated as a composite score (five-point Likert-type scale: 1=strongly disagree, 2=disagree, 3=neither, 4=agree, 5=strongly agree).

Subscales from PES-NWI and the composite score from HSOPSC were defined as organizational process measures in the present study.

Organizational structure measures

Theoretical considerations and the availability of data guided the selection of structure measures of the organizations. Based upon the results from an expert panel consensus on what features are important in order to evaluate patient safety interventions, we included variables that describe hospital type and size, patient clinical complexity, and professional staffing[23]. All of these are proposed as important control variables in several studies[4,12,24,25]. Structural characteristics were collected from public registers, reported from hospital administrations on our request, or aggregated from the RN4Cast-data[26]. "Regional hospitals" was defined as university hospitals with national responsibilities, while "central hospitals" was defined as university hospitals without national responsibilities. All other hospitals were defined as "local hospitals".

The following variables were defined as organizational structure measures:

- Nurse–patient ratio[27]
- Physician–patient ratio [27]
- Index for patient mix[26]
- Hospital size[26]
- Hospital type
    - Regional hospital status (versus local)
    - Central hospital (versus local)
- Bed occupancy (hospital reported)
- Nurse affiliation to medical department (versus surgical department) (nurse survey)
- Nurse experience in years per hospital (nurse survey)

Statistical analysis

All analyses were made using SPSS version 15.0.

Principal axis factoring with promax rotation was used to identify the factor structure of PES-NWI. Internal consistency was evaluated based on the complete Norwegian data set with nurses in intensive care units, medical wards, and surgical wards (n=5490). Items scoring less than 0.3 were excluded. Correlations were made to compare the results with factor structures identified in other studies.

A reliability test was performed to test the consistency of the HSOPSC composite measure.

Nurses from intensive care units were excluded in the following analyses because the number of these units, the size, and the type of patients admitted vary between hospitals. Based on recommendations for cut points for response rates we included 31 hospitals with a survey response rate above 40% [28]. In these hospitals the questionnaire was distributed to 6147 nurses in medical and surgical wards, and 3618 responded (mean response rate: 58.9%).

Scores of dependent and independent variables were transformed into a 0–100 scale, 0 representing the lowest possible score and 100 the highest possible score. Organizational structure measures were transformed into variables relative to hospital status to control for the assumption of dependency between hospital type and structural variables (in the following marked with "R" in variable names). The transformation was made by subtracting the mean values of hospital type for each case.

Univariate linear regressions were made to study the associations between each explanatory variable and the four outcome measures. This was followed up by stepwise multivariate regression with possible interactions included in the model. Those interactions that remained

significant on a 0.05 level were included in the following analyses. Interactions between hospital type and the other structural variables were related to features of single hospitals, and in the final multivariate regression model we removed these interactions.

The unit of observation was individuals, and nurse characteristics are presented at an individual level. Descriptive statistics of organizational structure and process measures were made on the hospital-aggregated level.

Results

The structural characteristics of hospitals included in the survey are described in table 1. Most of the hospitals were categorized as local (23), but three hospitals were central hospitals and another five were regional hospitals.

Table 1: Organizational structure measures

Hospital characteristics	**Median**	**Min.–max.**
Hospital size[1)]	414	85–958
Number of patient days	189,461	31,000–344,602
Index for patient mix[2)]	8.0	6.9–11.3
Physician–patient ratio [3)]	20.5	9.6–38.8
Nurse–patient ratio [4)]	53.3	29.9–82.9
Response rate on nurse survey	63.1	45.6–85.6
Nurses' work experience per hospital[5)]	8.6	4.1–13.3
Bed occupancy[6)]	87.3	75.2 –102.7

1) Number of beds 2) The ratio between the number of DRG-points and the number of admissions 3) Number of physician-years per 10,000 patient days 4) Number of nurse-years per 10,000 patient days 5) Mean years of experience among the respondents per hospital 6) Percent, bed occupancy for 2009

The mean age of nurse respondents in the survey was 35.6 (median 33, range 21–71), and their mean experience as nurses was 8.4 (median 5, range 0–45). Most nurses were female (93.8%). All registered nurses in Norway hold a Bachelor's degree, but 15.3% of the respondents had further education. The distribution of nurses between hospital types was

13.6% for central hospital and 29.2% for regional hospital. The distribution between departments was about even, with 56.4% of nurses working in medical departments.

In the exploratory factor analysis six subscales were identified, and two of the items from the original PES-NWI were excluded because Cronbach's alpha was lower than 0.3. Cronbach's alpha ranged from 0.68 to 0.88, with nurse participation in hospital affairs as the lowest and collegial nurse–physician relationship as the highest (see table 2). The items included in each subscale are shown in figure 2 (online only).

Table 2 Cronbach's alphas from principal axis factoring with promax rotation

Subscales	**Number of items**	**Cronbachs alpha**
Staff adequacy	3	0.80
Nurse physician relation	7	0.88
Ward leadership	4	0.78
Nursing participation (in hospital affairs)	5	0.68
Education and career (possibilities)	4	0.73
Quality system	7	0.71

Pearson's correlations between the principal axis factoring of the Norwegian data and the original factor structure presented by Lake are shown in table 3 (online only)[29].

Reliability testing of the composite score made by three items from HSOPSC gave a Cronbach's alpha of 0.72.

The respondents' characterizations of organizational process measures aggregated at hospital level are presented in table 4. The lowest scores were obtained for nurse representation of hospital affairs and staff adequacy, while agreement with good nurse–physician relationship and ward leadership was high.

Table 4 Organizational process measures

Hospital characteristics	Median	Min.–max.
Patient safety management	54.6	43.5–64.8
Staff adequacy	44.3	25.4–61.3
Nurse–physician relation	67.6	60.3–76.7
Education and career possibilities	48.8	33.2–71.2
Quality system	52.5	42.5–65.0
Nurse representation in hospital affairs	38.9	29.0–53.1
Ward leadership	61.7	50.0–77.8

Univariate linear regression showed that, with a few exceptions, organizational structure and process measures were associated with nurses' assessments of quality of nursing, patient safety, self-care ability, and absence of adverse events (see table 5, online only). The explanatory variables and interactions found significant in the stepwise model were analysed in a multivariate model with all main effects of the interactions included (table 6).

Table 6 Association between nurses' assessments of organizational measures and work- and patient-related outcomes

		Work-related outcomes		Patient-related outcomes	
		Quality of nursing	**Patient safety**	**Self-care ability**	**Absence of adverse events**
		Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)
Process measures	Patient safety management	0.10 (<0.001)	0.20 (<0.001)	0.14 (<0.001)	0.06 (<0.001)
	Staff adequacy	0.15 (<0.001)	0.13 (<0.001)	0.12 (<0.001)	0.06 (<0.001)
	Nurse–physician relation	0.06 (0.001)	0.06 (<0.001)	0.07 (0.020)	
	Education and career possibilities				
	Quality system	0.25 (<0.001)	0.18 (<0.001)	0.20 (<0.001)	0.10 (<0.001)
	Nurse representation in hospital affairs	-0.05 (0.011)			
	Ward leadership	0.04 (0.034)			-0.05 (<0.001)
Structure measures	Central hospital				-2.44 (<0.001)
	Regional hospital	3.45 (<0.001)	2.12 (0.002)	1.71 (<0.122)	
	Nurse–patient ratio-R			0.20 (0.025)	
	Physician–patient ratio-R			-0.26 (0.145)	
	Bed occupancy-R		0.01 (0.905)	-0.20 (0.016)	-0.08 (0.007)
	Index for patient mix-R	0.00 (0.994)		0.11 (0.212)	
	Nurse experience-R			-0.72 (0.014)	0.37 (<0.001)
	Hospital size-R			-0.02 (0.446)	
	Medical versus surgical department	0.32 (0.572)	-0.96 (0.033)	-5.48 (<0.001)	
Interactions	Index for patient mix-R * medical specialty	0.12 (0.068)			
	Nurse–patient ratio-R * nurse experience-R			0.17 (<0.001)	
	Physician–patient ratio-R * nurse experience-R			-0.27 (0.006)	
	Bed occupancy-R * medical specialty		-0.11 (0.104)	-0.11 (0.104)	

Nurses' assessments of work-related outcome measures, quality of nursing, and patient safety, were associated with four of the organizational process measures; patient safety management, staff adequacy, nurse–physician relationship, and quality system. We found positive associations between work-related outcome measures and working in a regional rather than a local hospital. Nurses affiliated with surgical wards gave higher ratings for patient safety than nurses working in medical wards.

The patient-related outcome measures, self-care ability, and absence of adverse events, were associated with the organizational process measures patient safety management, staff adequacy, and quality system. Bed occupancy was negatively associated with patient outcomes, meaning that lower bed occupancy gave higher (better) ratings for patient outcomes.

Working in a local versus central hospital gave higher ratings for absence of adverse events. Nurse experience was positively associated with absence of adverse events. We found a negative but marginal effect of ward leadership.

Nurse–physician relationship and nurse–patient ratio were positively associated with self-care ability, and working in a surgical department gave higher ratings of self-care ability. Nurse experience-R was negatively associated with self-care ability. The positive effect of nurse–patient ratio was increased by lower nurse experience. The interaction between physician–patient ratio and nurse experience gave opposite results. Index for patient mix increased the effect of working in a surgical department.

Discussion

Main findings

Our findings suggest that organizational processes are associated with both work- and patient-related outcome measures. Active programmes to ensure quality (quality system), management that encourage patient safety (patient safety management), and having sufficient staff to provide quality of care (staff adequacy) are consistently related to how nurses perceive patient outcomes, patient safety, and quality of nursing. Nurse–physician relationship was associated with work-related outcome measures and patients' self-care ability. Working in a regional hospital gave higher ratings for work-related outcomes. For patient-related outcomes the effect of low bed occupancy was significant, and nurse–patient ratio was positively associated with how nurses assessed patients' self-care ability.

Principal axis factoring

The exploratory factor analysis of PES-NWI on the Norwegian data specified six subscales that differed slightly from the five-subscale-set identified in previous studies[29]. Principal axis factoring gave no obvious indication on what factor set to prefer, but theoretical considerations made the six-factor-set preferable as it provides a more nuanced description of processes in the work system.

Nurses perceptions of patient- and work-related outcomes

Our study showed an association between all outcome measures and the subscale quality system, representing topics such as presence of quality control programmes, systems for

documentation, continuity of nursing, and training for newly hired. The existence of standards and quality systems might contribute to expectations and predictability for the organizations and the health professionals working within them[30]. The presence of routines and infrastructure related to information technology is critical for adequate documentation and coordination of care[1,18]. In a study from 1985 Haley found that the presence of an infection control programme was a cost-effective measure to prevent nosocomial infections[31], and other studies have showed that quality programmes influence health care workers attitudes and increase improvement events[32,33]. Continuity of nursing and nursing versus medical orientation are elements of the subscale quality system, implying that nursing aspects of workflow and processes should be addressed.

In a review to identify high-performing work systems, internal training programs are suggested as one of many elements[34]. Having a training programme for newly hired is an element of the subscale quality system in our study. However, the subscale education and career development was not associated with outcome measures. This may indicate that integrated training programmes are more important than nurses's opportunities for individual professional development and career advancement when it comes to how they perceive patient safety and quality.

The importance of a management that prioritizes patient safety is outlined in several studies and supported in our findings through the subscale patient safety management involving discussion and feedback on adverse events and actions showing that patient safety has top priority[35,36]. Listyowardojo et al. found that physicians rated institutional commitment to safety more positively than nurses did[14]. A possible explanation is that communication between hospital management and physicians functions more fluently. In our study patient safety management was associated with all outcome measures, which underlines the importance of well-functioning channels to communicate hospital managements' engagement

in patient safety to all health care professions. The effects of audits and performance feedback on process measures have been confirmed in numerous studies, even though the results are inconsistent[37-40]. It is suggested by Ivers et al. that this depend on how feedback is provided[37]. Hence, the channels for communicating results from performance measurements and other patient safety messages should probably be formed by the preferences of the target health care profession[37].

Collegial discussions are essential to professional development, and communication in general is an important aspect of workflow and patient safety[41,42]. It is suggested by several authors that teamwork is fundamental to the administration of workflow[43-45].When our findings show that the relationship between nurses and physicians is associated with work-related outcomes and patients' self-care ability, the association between good nurse–physician relationships and high-quality of care from other studies is supported[46].

Nurses' perceptions of staff adequacy were significant for all four outcome measures in the present study. Staff adequacy represents nurses' assessments of the possibility to get the work done, provide quality of care, and discuss problems related to care with colleagues. The results are supported by international research suggesting that deployment of resources is essential to patient safety[47]. Adequate and targeted resource allocation can contribute to reduced length of stay, increase in ambulatory activity, as well as ensuring right competence at the right place and time[48].

In the present study nurse–patient ratio was only associated with self-care ability. Bed occupancy was associated with patient-related outcomes, indicating that workload has an impact on how nurses evaluate patient outcomes. Associations between staff ratios and patient outcomes such as failure to rescue, unplanned extubation, cardiac arrest, nosocomial infections, and risk-adjusted mortality have been found in several studies, indicating that staff

levels are related to quality and patient safety[8,11,50-54]. Corresponding results have been shown in studies with nurse-reported outcome measures[52-54]. In a qualitative study where hospital employees were invited to suggest patient safety interventions, increased staffing was ranked as the most important measure[49]. The absence of relationships between nurse staffing and nurse-reported outcomes in our study may be explained by the high nurse–patient ratios in Norway compared to other countries. This may indicate that passing a threshold for staff levels, challenges related to quality, and patient safety could be met on an organizational level[19,21,56].

In this study we found that nurses assess quality of nursing and patient safety higher in regional hospitals than in local hospitals, but this was not the case for nurse-assessed patient outcomes. The gap in results between work- and patient-related outcomes may be explained by the type of care delivered and risks for complications among patients in regional hospitals. Even though complications happen more often nurses' perception of quality and safety may be good. However, associations between hospital type and patient safety indicators are inconsistently reported by other authors, and it is suggested that features other than hospital type are more important for patient outcome[12,55].

Limitations

In the present study the survey design involves a risk of common method bias as all variables were obtained from the same questionnaire. This may have influenced the results, and must be considered when reading the results. The same caution should be made regarding the small coefficients produced in our analyses.

Methodological questions related to cross-sectional survey design are often addressed towards the inadequacy to prove causality. However, the intention of our study was not to add proof of

this kind, but to describe how nurses' perceptions of work environment were associated with the outcomes.

The questionnaires were distributed through the nurses' union representatives, and the survey results may have been affected by the distribution method.

Conclusion

Organizational structures may have impact on how nurses perceive work- and patient-related outcomes. However, the organizational processes consistently related to all outcomes measures, indicate that there is a considerable potential to address organizational design in improvement of patient safety and quality of care. Our findings contribute to an understanding of how interventions should be targeted towards nurses as one major microsystem of the organization.

Ethical approvals: The method of data collection and handling was approved by the Data Protection Official for Research

Acknowledgements: The authors would like to thank all Norwegian nurses that responded on the nurse survey.

Competing interests: None

Funding: Data were collected by Norwegian Nurses' Organisation and Norwegian Knowledge Centre for the Health Services in collaboration. Christine Tvedt was supported by a grant from Norwegian Nurses' organisation.

Data sharing statement: The data set is available at The Norwegian Knowledge Centre for the Health Services, and requests should be addressed by emailing cht@nokc.no

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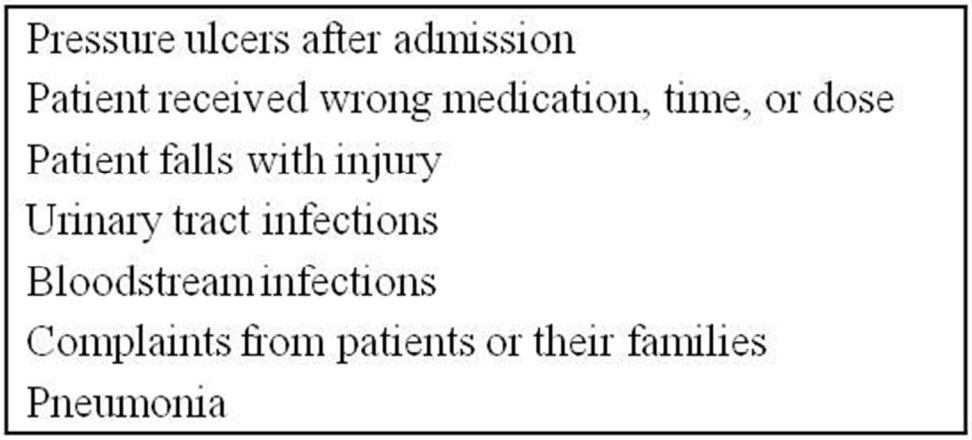

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Education and career possibilitites	Career development/clinical ladder opportunity A supervisory staff that is supportive of the nurses Active staff development or continuing education programs for nurses Opportunities for advancement
Nurse participation in hospital affairs	Opportunity for staff nurses to participate in policy decisions A chief nursing officer who is highly visible and accessible to staff A chief nursing officer equal in power and authority to other top-level hospital executives Staff nurses are involved in the internal governance of the hospital (e.g., practice and policy committees) Staff nurses have the opportunity to serve on hospital and nursing committees
Quality system	A clear philosophy of nursing that pervades the patient care environment Working with nurses who are clinically competent An active quality assurance program A preceptor program for newly hired RNs Nursing care is based on a nursing, rather than a medical, model Written, up-to-date nursing care plans for all patients Patient care assignments that foster continuity of care, i.e., the same nurse cares for the patient from one day to the next
Ward leadership	A nurse manager who is a good manager and leader Praise and recognition for a job well done A nurse manager who backs up the nursing staff in decision making, even if the conflict is with a physician Administration that listens and responds to employee concerns
Staff adequacy	Enough time and opportunity to discuss patient care problems with other nurses Enough registered nurses to provide quality patient care Enough staff to get the work done
Nurse physician relation	Physicians and nurses have good working relationships A lot of team work between nurses and physicians Collaboration (joint practice) between nurses and physicians Physicians value nurses' observations and judgments Physicians recognize nurses' contributions to patient care Physicians respect nurses as professionals Physicians hold nurses in high esteem

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Table 3 Pearson's correlation between factors identified by principal axis factoring on present data and factors identified by Lake.

	Staff adequacy	Nurse physician relation	Education and career possibilities	Quality system	Nursing participation in hospital affairs	Ward leadership
Staffing and Resource Adequacy	0.95 (<0.001)	0.31 (<0.001)	0.51 (<0.001)	0.52 (<0.001)	0.44 (<0.001)	0.43 (<0.001)
Collegial Nurse–Physician Relations	0.29 (<0.001)	1.00 (<0.001)	0.34 (<0.001)	0.37 (<0.001)	0.29 (<0.001)	0.36 (<0.001)
Nurse Manager Ability, Leadership, support	0.45 (<0.001)	0,42 (<0.001)	0.62 (<0.001)	0.53 (<0.001)	0.48 (<0.001)	0.91 (<0.001)
Nursing Foundations for Quality of Care	0.53 (<0.001)	0.39 (<0.001)	0.67 (<0.001)	0.97 (<0.001)	0.55 (<0.001)	0.53 (<0.001)
Nurse Participation in Hospital Affairs	0.49 (<0.001)	0.34 (<0.001)	0.74 (<0.001)	0.58 (<0.001)	0.92 (<0.001)	0.65 (<0.001)

Table 5 Univariate linear regression (online-only)

	Quality of nursing	**Patient safety**	**Self-care ability**	**Absence of adverse events**
	Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)
Patient safety management	0.29 (<0.001)	0.35 (<0.001)	0.30 (<0.001)	0.10 (<0.001)
Adequate staffing	0.29 (<0.001)	0.28 (<0.001)	0.26 (<0.001)	0.10 (<0.001)
Nurse physician relation	0.22 (<0.001)	0.22 (<0.001)	0.18 (<0.001)	0.06 (<0.001)
Education and career possibilities	0.24 (<0.001)	0.23 (<0.001)	0.20 (<0.001)	0.05 (<0.001)
Quality system	0.43 (<0.001)	0.41 (<0.001)	0.40 (<0.001)	0.14 (<0.001)
Nurse representation in hospital affairs	0.25 (<0.001)	0.25 (<0.001)	0.23 (<0.001)	0.06 (<0.001)
Ward leadership	0.25 (<0.001)	0.25 (<0.001)	0.23 (<0.001)	0.04 (<0.001)
Nurse-patient ratio	0.17 (<0.001)	0.17 (<0.001)	0.29 (<0.001)	0.05 (0.013)
Physician-patient ratio	0.24 (<0.001)	0.15 (0.006)	0.29 (0.002)	-0.21 (0.607)
Central hospital	-1.74 (0.045)	-2.92 (<0.001)	-0.69 (0.582)	-2.98 (<0.001)
Regional hospital	3.92 (<0.001)	2.33 (<0.001)	4.43 (<0.001)	-0.28 (0.498)
Mean occupancy	-0.18 (<0.001)	-0.17 (<0.001)	-0.16 (<0.001)	-0.16 (<0.001)
Index for patient mix	0.17 (<0.001)	0.13 (<0.001)	0.13 (0.005)	0.02 (0.393)
Mean nurse experience	0.39 (0.005)	-0.44 (<0.001)	-0.67 (0.001)	0.34 (<0.001)
Hospital size	-0.09 (0.419)	-0.09 (<0.001)	-0.11 (<0.001)	-0.04 (<0.001)
Medical specialty (vs surgical)	1.26 (0.037)	0.24 (0.642)	-4.46 (<0.001)	-0.14 (0.719)

Figure 2. Items included in factors identified by principal axis factoring

Education and career possibilitites	Career development/clinical ladder opportunity
	A supervisory staff that is supportive of the nurses
	Active staff development or continuing education programs for nurses
	Opportunities for advancement
Nurse participation in hospital affairs	Opportunity for staff nurses to participate in policy decisions
	A chief nursing officer who is highly visible and accessible to staff
	A chief nursing officer equal in power and authority to other top-level hospital executives
	Staff nurses are involved in the internal governance of the hospital (e.g., practice and policy committees)
	Staff nurses have the opportunity to serve on hospital and nursing committees
Quality system	A clear philosophy of nursing that pervades the patient care environment
	Working with nurses who are clinically competent
	An active quality assurance program
	A preceptor program for newly hired RNs
	Nursing care is based on a nursing, rather than a medical, model
	Written, up-to-date nursing care plans for all patients
	Patient care assignments that foster continuity of care, i.e., the same nurse cares for the patient from one day to the next
Ward leadership	A nurse manager who is a good manager and leader
	Praise and recognition for a job well done
	A nurse manager who backs up the nursing staff in decision making, even if the conflict is with a physician
	Administration that listens and responds to employee concerns
Staff adequacy	Enough time and opportunity to discuss patient care problems with other nurses
	Enough registered nurses to provide quality patient care
	Enough staff to get the work done
Nurse physician relation	Physicians and nurses have good working relationships
	A lot of team work between nurses and physicians
	Collaboration (joint practice) between nurses and physicians
	Physicians value nurses' observations and judgments
	Physicians recognize nurses' contributions to patient care
	Physicians respect nurses as professionals
	Physicians hold nurses in high esteem

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AN OBSERVATIONAL STUDY TO IDENTIFY ORGANIZATIONAL PROCESSES ASSOCIATED WITH NURSE-REPORTED QUALITY AND PATIENT SAFETY

Journal:	*BMJ Open*
Manuscript ID:	bmjopen-2012-001967.R1
Article Type:	Research
Date Submitted by the Author:	20-Oct-2012
Complete List of Authors:	Tvedt, Christine; Norwegian Knowledge Centre for the Health Services, Department of Quality Measurement and Patient Safety; University of Oslo, Institute of Health and Society Sjetne, Ingeborg; Norwegian Knowledge Centre for the Health Services Helgeland, Jon; The Norwegian Knowledge Centre for the Health Services, Department of Quality Measurement and Patient Safety Bukholm, Geir; Østfold Hospital Trust, Centre for Laboratory Medicine
Primary Subject Heading:	Health services research
Secondary Subject Heading:	Health services research
Keywords:	Organisation of health services < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Quality in health care < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Health & safety < HEALTH SERVICES ADMINISTRATION & MANAGEMENT

Title:

AN OBSERVATIONAL STUDY TO IDENTIFY ORGANIZATIONAL PROCESSES ASSOCIATED WITH NURSE-REPORTED QUALITY AND PATIENT SAFETY

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Key-words:

Patient safety, performance measures, nurses, survey, quality measurement.

Word count: 3788

ABSTRACT

Objectives: The purpose of this study was to identify organisational processes and structures that are associated with nurse-reported patient safety and quality of nursing. Health care workers' perceptions related to patient safety vary by disciplines within the health care organisations, and organizational design promoting patient safety among nurses as a micro system of hospitals is studied

Design: This is an observational cross-sectional study using survey methods

Setting: Respondents from 31 Norwegian hospitals with more than 85 beds were included in the survey.

Participants: All registered nurses working in direct patient care in a position of 20 % or more were invited to answer the survey. In this study 3618 nurses from surgical and medical wards responded (response rate 58.9). Nurses practice environment was defined as organisational processes and measured by the *Nursing Work Index Revised* and items from *Hospital Survey on Patient Safety Culture.*

Outcome measures: Nurses' assessments of patient safety, quality of nursing, confidence in how their patients manage after discharge and frequency of adverse events were used as outcome measures.

Results *Quality system*, *nurse-physician relation*, *patient safety management* and *staff adequacy* were process measures associated with nurse-reported work- and patient- related outcomes, but we found no associations with *nurse participation*, *education and career* and *ward leadership*. Most organisational structures were non-significant in the multilevel model except for nurses' affiliations to *medical department* and *hospital type*.

Conclusion Organisational structures may have minor impact on how nurses perceive work- and patient related outcomes, but the findings in this study indicate that there is a considerable

potential to address organizational design in improvement of patient safety and quality of care.

Article focus

- Identifying organizational processes and structures associated to nurse-reported quality and patient safety in hospitals
- Increase knowledge about organizational design promoting patient safety among nurses as a micro system of hospitals

Key messages

- Organizational processes may have a considerable potential to address organizational design in improvement of patient safety and quality of care.

Strengths and limitations

- A considerable number of nurses have given their responses on a multicenter nurse survey providing a valuable data material.
- Several aspects of the survey method may have influenced the results of this study

AN OBSERVATIONAL STUDY TO IDENTIFY ORGANIZATIONAL PROCESSES ASSOCIATED WITH NURSE-REPORTED QUALITY AND PATIENT SAFETY

Introduction

The report "Crossing the quality chasm" from the Institute of medicine in 2001 called for a system change to improve safety in the health care services[1]. The report led to establishment of patient safety programmes and health care reforms in many Western countries. The introduction of evidence-based practice, guidelines, performance measurements, and feedback

has characterized patient safety initiatives in hospitals during the last decade. Results from evaluations of the interventional efforts are inconsistent, and several authors have described a need to better understand how organizational features contribute to quality and patient safety in hospitals[2-4]. The organizational climate is defined by the employees' perceptions of these features, and might be understood as structural properties of the organisation and employees' perceptions of their organisational environment[5]. Both organizational structures (e.g. hospital size, hospital volume) and organisational processes (e.g. patient safety climate, perception of work environment) have been associated with safety outcomes[4-6].

The system perspective is based on how input to the health care system is managed and how this input benefits the patients and society [1]. Donabedian's model for quality serve as a framework to understand how hospital structures and processes contribute to health care outcomes and the model is modified by Battle et al to illustrate how processes exist within the structure of the healthcare system[7-9]. Battles describe how adjustments of organisational structures and processes may contribute to a reduction of failures that cause adverse events. An organisational climate where processes and structures allow patient safety improvements is required to minimize the failures of care[3,9]. Inertia of organizational change observed in health care institutions is suggested as one explanation for why the "progress of patient safety improvements has been slow"[3]. A leadership with clear visions and strategies is a key to transformational change towards a patient safe organization, and knowledge about how health care workers assess their work environment and patient safety in their work place should therefore be essential to these leaders[10].

The growing body of evidence on how work environment is associated with healthcare performance support this view. In studies of physicians' work environment associations with the quality of health service delivery have been presented and improvement of nurses' work

environment is suggested as a cost effective strategy to improve patient outcomes[11-15]. Several studies have presented associations between nurses' work environment and patient outcomes like adverse events, risk-adjusted mortality and patient satisfaction[15-21]. These are important studies identifying associations between patient outcome and features of the health care organisation. However, information about how health care workers take advantage of processes and structures in the organization is essential for design of patient safe health care organisations[9,22,23].

Attitudes and perceptions related to patient safety vary by disciplines and micro systems. The planning and implementation of strategies and interventions to improve patient safety should take such variations into account[22,24-27]. . Despite the fact that nurse-reported quality of care have been associated with failure to rescue, patient satisfaction and processes of care, a small number of studies has explored how nurse-reported patient safety is associated with work environment[28 29 30-33].

Objectives

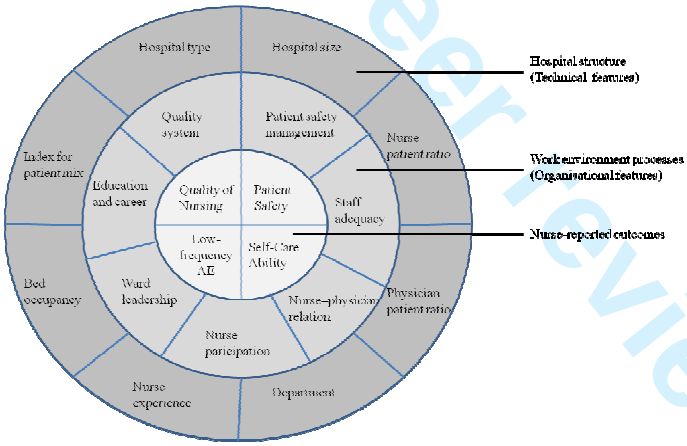
Nurses constitute a large proportion of health care workers, and how they perceive an organizational design promoting patient safety is essential information about nurses as a microsystem[4,8,34]. The purpose of this study was to identify organisational process measures in nurses' work environment and hospital characteristics (organisational structure measures) that were associated with nurse-reported patient safety and quality of nursing. In particular, we were interested in which process measures remained after adjusting for organisational structure measures.

Methods

Design

The theoretical approach of this observational cross sectional study was based on Donabedian's dimensions of a quality model: structure, process and outcome. We modified Battles' version of this model to illustrate how hospital characteristics, nurses' work environment and nurse-reported quality of nursing and patient safety were nested (figure 1). The readers should bear in mind that these variables only represent part of a complex reality.

Figure 1 Modification of the Battles model to illustrate the nested relationship of structure, process and outcome [7]



Data collection

This study involved a survey among nurses in surgical and medical wards in 35 Norwegian hospitals with more than 85 beds. The data collection was part of the European RN4Cast study[11]. A paper questionnaire, information letter, and return envelope were distributed through the nurses' union representatives to 6600 nurses during the autumn of 2009. Registered nurses working in direct patient care in a position of 20% or more were included, and nurses on long-term leaves were excluded. Nurses received the questionnaire at their

workplaces, and the distribution procedures included collection of information about nurses' affiliations to hospital, department and ward. Personal reminders were not distributed as the respondents' names and addresses were not available to the researchers. In some hospital wards the union representatives and/or nurse leaders gave collective reminders. The method of data collection and handling was approved by the Data Protection Official for Research.

Nurse-reported outcome measures

The use of self-reported outcomes in this study was necessary to describe how nurses perceived quality of nursing and patient safety at their work places. Single-item overall assessment of quality of nursing and patient safety were used as outcome variables as practiced in other studies investigating nurse-reported quality and patient safety[30-33,35]. We defined the four questions as variables that describe "work-related" referring how nurses report work performance related to patient safety and "patient-related" referring to nurses' reports of patient outcomes:

Work-related outcome measures

- Quality of Nursing: In general, how would you describe the quality of nursing care delivered to patients on your unit/ward? (four-point Likert-type scale where 1=poor, 2=fair, 3=good, and 5=excellent, meaning that high scores indicate better quality)
- Patient Safety: Please give your department an overall grade on patient safety. (5-point Likert-type scale where 1=failing, 2=poor, 3=acceptable, 4=very good, and 5=excellent, meaning that high scores indicate better Patient Safety)

Patient-related outcome measures

- Self-Care Ability: How confident are you that your patients are able to manage their care when discharged? (four-point Likert-type scale where 1=not at all confident,

2=somewhat confident, 3=confident, and 4=very confident, meaning that high scores indicate more confidence in how patients manage)

- Low Frequent AE: Nurses were also asked to estimate how frequently adverse events have happened to their patients on a seven-point Likert-type scale (1=never, 2=some times per year, 3=once a month or less, 4=some times per month, 5=once a week, 6=some times per week, 7= every day). We recoded the subscale into the opposite direction so that the lowest frequency (Low frequency AE = preferably) made the highest scores.

Different types of adverse events where subjects of the question and in this study we calculated the mean of the seven adverse events scores per nurse:

- Pressure ulcers after admission
- Patients received wrong medication, time or dose
- Patient falls with injury
- Urinary tract infections
- Bloodstream infections
- Complaints from patients or their families
- Pneumonia

Organizational process measures

Nurses' work environment was measured by the instrument *Nursing Work Index* (NWI)[36] and a subscale including items from *The Hospital Survey on Patient Safety Culture* (HSOPSC)[37]. These subscales were regarded as organizational processes and made the following variables:

- *Education and career*
- *Nurse participation*
- *Quality system*
- *Ward leadership*
- *Staff adequacy*
- *Nurse physician relation*

- *Patient safety management*

. The Norwegian version of NWI has been translated and tested according to acknowledged procedures for questionnaire modifications between cultures[38]. We performed an exploratory analysis to identify the factor structure of the Norwegian dataset. The subscales identified were used as explanatory variables in the study.

The items were four-point Likert-type scales, and high scores indicated agreement that the items were present in the job situation (1=strongly disagree, 2=somewhat disagree, 3=somewhat agree, and 4=strongly agree). The scale scores were calculated as the single items' average for all respondents who had valid scores on at least half of the items included in the scale in question.

Leadership is essential for development of organisational/patient safety culture, and we included three items from the HSOPSC-questionnaire[37,39,40]. The items represent leadership topics such as performance feedback and actions showing that patient safety have priority in hospital management. We regarded a subscale of these items as process measure for the work environment. High scores indicated agreement that the items were present in the job situation (five-point Likert-type scale: 1=strongly disagree, 2=disagree, 3=neither, 4=agree, 5=strongly agree).

Organizational structure measures

Information about the hospitals were collected from public registers, reported from hospital administrations on our request, or aggregated from the survey data[41,42]. The following measures were used as organizational structure variables:

- *Nurse–patient ratio* (Number of nurse man-years per 10,000 patient days, 2009) [42]

- *Physician–patient ratio* (Number of physician man-years per 10,000 patient days, 2009) [42]
- *Index for patient mix* (The ratio between the number of DRG-points and the number of admissions, 2009)[41]
- *Hospital size* (Number of beds, 2009)[41]
- *Hospital type* (made as two dummy-variables):
    - *Regional university hospital* (reference value: local hospital)
    - *Local university hospital* (reference value: local hospital)
- *Bed occupancy* (mean bed occupancy in percent for 2009, hospital reported)
- *Medical department* (from the nurse survey: Nurses' affiliation to medical department with reference value: surgical department)
- *Nurse experience* (in years per hospital derived survey data)

"*Regional university hospitals*" were defined as university hospitals with national responsibilities, while "*local university hospitals*" were defined as university hospitals without national responsibilities. All other hospitals were defined as "local hospitals". We collected organisational structure measures to ensure validity and comparability for all hospitals included in the survey. The measures selected for this study was chosen after considerations of literature discussing the context of patient safety research and practices. To describe and classify patient safety practices and research hospital type and size, patient clinical complexity, and professional staffing are suggested as essential structural features[4,6,43,44 45].

Statistical analysis

All analyses were made using SPSS version 15.0.

We used exploratory factor analysis to examine the structure of NWI in the Norwegian dataset, involving intensive care units, medical and surgical wards (n=5490). We performed reliability tests to obtain internal consistency for these subscales and for the subscale from HSOPSC.

The questionnaire was distributed to 6147 nurses in medical and surgical wards, and 3618 responded (mean response rate: 58.9%). Based on recommendations for cut points for response rates we included 31 hospitals with a survey response rate above 40% [46]Nurses from intensive care units were excluded in the because the number of these units, the size, and the type of patients admitted vary between hospitals..

Scores of outcome and explanatory variables were transformed into a 0–100 scale, 0 representing the lowest possible score and 100 the highest possible score. Organizational structure variables were transformed into variables relative to *hospital type* to control for the assumption of dependency with *hospital type* (in the following marked with "R" in variable names). The transformation was made by subtracting the mean values of *hospital type* for each case. The unit of observation was individuals. Descriptive statistics of organizational structure measures were made at hospital-aggregated level.

Initially bivariate regression analysis for each organisational variable and each nurse-reported outcome was performed. In the stepwise multivariate regression that followed, all organisational variables and all potential interactions were included. Main effects and interactions that remained significant on a 0.05 level were included in the final multivariate multilevel regression introducing hospital ward and hospital as level 2 and 3 variables. Interactions between *hospital type* and other structural variables were removed in the final model because they were related to features of single hospitals.

Results

The exploratory factor analysis identified six subscales from NWI, and internal consistency (Cronbach's alpha) ranged from 0.68 to 0.88 in the reliability test (see table 1). Construction of the subscales and the subscales from PES-NWI[36] are presented in figure 2 (online-only). Internal consistency (Cronbach's alpha) of the three items from HSOPSC was 0.72.

Table 1 Internal consistency (Cronbach's alpha) of subscales from NWI

Subscales	**Number of items**	**Internal consistency** (Cronbach's alpha)
Staff adequacy	3	0.80
Nurse physician relation	7	0.88
Ward leadership	4	0.78
Nurse participation	5	0.68
Education and career (possibilities)	4	0.73
Quality system	7	0.71

The structural characteristics of hospitals are described in table 2. Most of the hospitals were categorized as local (23), but three hospitals were *local university hospitals* and another five were *regional university hospitals*.

Table2: Characteristics of the included hospitals (N=31)

Hospital characteristics	**Median**	**Min.–max.**
Hospital size[1)]	414	85–958
Index for patient mix[2)]	8.0	6.9–11.3
Physician–patient ratio[3)]	20.5	9.6–38.8
Nurse–patient ratio[4)]	53.3	29.9–82.9
Nurse experience (no. of years per hospital[5)])	8.6	4.1–13.3
Bed occupancy[6)]	87.3	75.2 –102.7

1) Number of beds 2) The ratio between the number of DRG-points and the number of admissions 3) Number of physician-years per 10,000 patient days 4) Number of nurse-years per 10,000 patient days 5) Mean years of experience among the respondents per hospital 6) Percent, bed occupancy for 2009

About 90 % of Norwegian nurses are members of NNO, and mean age among these nurses are 43, 90 % were female. The mean age of nurse respondents (N=3618) in this study was 35.6 (median 33, range 21–71), and their mean experience as nurses was 8.4 (median 5, range 0–45). Most nurses were female (93.8%). All registered nurses in Norway hold a Bachelor's degree, and 15.3% of the respondents had further education. The distribution of nurses between *hospital types* was 13.6% for *local university hospital* and 29.2% for *regional university hospital*. The distribution between departments was about even, with 56.4% of nurses working in medical departments.

Organizational process variables are presented in table 3. *Nurse participation* and *staff adequacy had the lowest scores*, while *nurse-physician relation* and *ward leadership had high scores*.

Table 3 Nurses' assessment of organizational process measures (N=3618)

Hospital characteristics	**N**	**Median**	**Min.–max.**	**SD**
Patient safety management	3556	58.3	0-100	18.7
Staff adequacy	3602	44.4	0-100	22.4
Nurse-physician relation	3602	66.67	0-100	15.9
Education and career	3603	50.0	0-100	20.5
Quality system	3594	52.4	0-100	15.8
Nurse participation	3641	40.0	0-100	17.6
Ward leadership	3612	66.67	0-100	20.6

Bivariate linear regression showed that, with a few exceptions, organizational structure and process measures were associated with nurses' reports of Quality of Nursing, Patient Safety, Self-Care Ability, and Low frequency AE (see table 4, online only). The final multivariate multilevel model introducing hospital ward and hospital as level 2 and 3 variables, showed that almost all variance was found on individual level, and demonstrated that correlation among observations within the hospitals was lower than for hospital wards(table 5). The correlation at hospital level accounted for 0.22 % – 0.74 % of the total variance, and correlation at hospital ward level accounted for 2.46 % – 8.64 % of the total variance (table 5).

Table 5 Multivariate multilevel regression analysis of process/structure measures and nurses' self-reported work- and patient-related outcomes (N=3618)

		Work-related outcomes		Patient-related outcomes	
		Quality of Nursing	**Patient Safety**	**Self-Care Ability**	**Low frequency AE**
		Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)
Process measures	*Patient safety management*	0.09 (<0.001)	0.19 (<0.001)	0.13 (<0.001)	0.06 (<0.001)
	Staff adequacy	0.12 (<0.001)	0.12 (<0.001)	0.10 (<0.001)	0.04 (<0.001)
	Nurse-physician relation	0.06 (0.003)	0.07 (<0.001)	0.08(0.006)	
	Education and career				
	Quality system	0.25 (<0.001)	0.18 (<0.001)	0.21 (<0.001)	0.09 (<0.001)
	Nurse participation	-0.04 (0.028)			
	Ward leadership	0.05 (0.011)			-0.03 (0.008)
Structure measures	*Local university hospital*				-3.08 (0.008)
	Regional university hospital	3.57 (0.003)	1.89 (0.024)	1.48 (<0.375)	
	Nurse–patient ratio-R			0.21 (0.127)	
	Physician–patient ratio-R			-0.28 (0.290)	
	Bed occupancy-R		0.00 (0.955)	-0.25 (0.055)	-0.09 (0.127)
	Index for patient mix-R	0.01 (0.861)		0.10 (0.415)	
	Nurse experience-R			-0.77(0.071)	0.33 (0.051)
	Hospital size-R			-0.02 (0.533)	
	Medical department	0.23 (0.769)	-1.12 (0.039)	-5.89 (<0.001)	
Interactions	*Index for patient mix-R * Medical department*	0.14 (0.114)		-0.28 (0.032)	
	*Nurse–patient ratio-R * nurse experience-R*			0.16 (0.013)	
	*Physician–patient ratio-R * nurse experience-R*			-0.28 (0.066)	
	*Bed occupancy-R * Medical department*		-0.10 (0.227)		

Intra class correlation	ICC hospital ward level (2) (percent)	5.68	2.46	5.35	8.64
	ICC hospital level (3) (percent)	0.56	0,72	0.22	0.74

The multivariate multilevel model showed that nurses' reports of work-related outcome measures; Quality of Nursing, and Patient Safety, were associated with four of the organizational process measures; *patient safety management*, *staff adequacy*, *nurse–physician relation*, and *quality system* (table 5). For Quality of Nursing we found small but significant coefficients of *nurse participation* (negatively) and *ward leadership* (positively).Working in a *regional university hospital* rather than a local hospital was associated with work-related outcome measures. Nurses affiliated to *medical departments* gave lower ratings of Patient Safety than nurses working in surgical departments.

The patient-related outcome measures; Self-Care Ability, and Low frequency AE, were associated with the organizational process measures *patient safety management*, *staff adequacy*, and *quality system*. Self-Care Ability was associated with *Nurse-physician relation* (positively), and Low frequency AE was associated with *ward leadership* (negatively). Nurses working in a *medical department* reported poorer Self-Care Ability. Nurses working a *local university hospital* rather than a local hospital reported higher frequency of adverse events (reduced Low frequency AE). The interactions included in the final model showed that *index for patient mix* reduced the negative effect of *medical department* on Self-Care Ability. High *nurse experience* per hospital increased the effect of *nurse-patient ratio* on Self-Care Ability. Except for *medical department* none of the main effects involved in the interactions were significant.

Low frequency AELow frequency AE**Discussion**

Main findings

Organisational process variables; *quality system, patient safety management, staff adequacy and nurse-physician relation* were associated with nurse-reported work- and patient- related outcomes. Not all process variables were associated with the outcomes. The organisational structure variables *medical department* and *hospital type* were associated with some of the nurse-reported outcomes.

Strengths and limitations

This study is based on data from one of the largest nurse surveys performed in Norway, and includes almost all Norwegian hospitals with more than 85 beds. Norwegian nurses give their workplaces better ratings of work environment and patient safety, and nurse-patient ratios are higher compared to other countries [11]. The good performance of Norwegian hospitals as assessed by nurses make it of particular interest to study the organisational design.

Questions related to cross-sectional survey design are often addressed towards the inadequacy to prove causality. However, the intention of our study was not to add evidence of this kind, but to describe associations between nurses' perceptions of work environment and their assessments of patient safety and quality of nursing. We have not made statistical controls to mitigate the risk of common method bias as the value of this is questioned[47-51]. The method for identifying the five-factor structure of nursing work index has been criticised, but is one of several ways to identify factor structure[52]. Internal consistency has been tested for both scales, and was higher for the six-factor structure identified in the present study and provided a nuanced description of work environment adapted to a Norwegian context [36 38]. The questionnaires were distributed through the nurses' union representatives, and we have not been able to control whether perspectives of NNO have influenced the results. The sample of this study is a relevant population with a response rate of 58.9%, and the age distribution is

corresponding with studies of similar populations from Norway[53]. The difference in age from nurses in the NNO database may be explained by exclusion of nurses in leader positions and part-time positions. Nurses' practice environments are complex and cannot be fully covered by a questionnaire, but overall the nursing work index is characterised as a "promising instrument"[52,54]. However, NWI is developed to evaluate nurse-reported job outcomes, and the applicability of the instrument to patient safety outcome might be uncertain[55]. Statistics Norway and The Norwegian Directorate of Health are well-established registers with complete coverage. The high quality of their data collection has minimized the risk of inaccuracy of organisational structure variables and ensured the comparability between hospitals.

Organisational process measures

Educational level has been associated with risk-adjusted patient mortality and failure to rescue within 30 days of admission[56,57]. Even though all Norwegian nurses hold a bachelor degree, we expected that *education and career* was associated with some of the outcome measures, but this was not the case. However, the association between *quality system,* involving issues as training for newly hired and continuity of nursing, and work- and patient- related outcomes indicate that integrated training programmes are more important for patient safety and quality of nursing[57]. The subscale *quality system* also represents continuous processes such as presence of quality control programmes, systems for documentation, and nursing versus medical orientation. These findings are supported in studies showing that quality programmes influence health care workers attitudes and increase improvement events[58-61]. The existence of standards, infrastructure and quality systems contribute to expectations and predictability for the health professionals and maximize their efforts to avoid patient harm [1,9,62]. .

The impact of nurse leadership and a management that prioritizes patient safety has been emphasised in several studies[10,40 63,64]. W*ard leadership* was inconsistently associated with

the outcomes in this study, but the leadership aspect was supported by the subscale *patient safety management.* In a recent study the authors found that engaged leadership strengthened both communication and teamwork and that these qualities of the organisation enhanced patient safety[65]. Communication and collegial discussions are important aspects to streamline workflow and procedures to ensure patient safety, and serve as sources for professional development[66,67]. The association between good nurse-physician relation and high quality of care from other studies was supported in our findings[68-71]. The channels for communicating results from performance measurements and other patient safety messages require engagement from leaders on all levels, and should probably be formed by the preferences of the targeted health care profession.

Staff adequacy represent nurses' assessments of the possibility to get the work done, provide quality of care, and discuss problems related to care with colleagues Processes that ensure adequate and targeted resource allocation may contribute to reduced length of stay, increase in ambulatory activity, as well as ensuring right competence at the right place and time[72 73]. Associations between staff ratios and patient outcomes such as failure to rescue, unplanned extubation, cardiac arrest, nosocomial infections, and risk-adjusted mortality have been found in several studies, indicating that staff levels are related to quality and patient safety[15,19,21,74-77]. Corresponding results have been shown in studies with nurse-reported outcome measures, but was not confirmed by our study[75-77]. A possible reason for this is that nurse-patient ratios are high in Norway and that Norwegian nurses perceive work environment better than nurses in other countries[11]. This may indicate that passing a threshold for staff levels, challenges related to quality, and patient safety could be met on an organizational level[11,23,78]. .

Organisational structure measures

Most of the organizational structures were not significantly associated with outcome variables when hospital and hospital ward was introduced as levels in the analysis. Hence, when affiliation to regional university hospitals remained significant, it may as well be explained by a strong common perception of the hospital performance as of *hospital type*. *Regional university hospital* was not associated with nurse-reported patient-related outcomes implying that nurses' perception of quality and safety may be good despite the risk for complications among patients in these hospitals. Associations between hospital type and patient safety indicators are inconsistently reported by other authors that suggest that features other than hospital type are more important for patient outcomes[6,79,80]

The negative association between Low frequency AE and *local university hospital* might confirm the assumption that common perception is a more decisive factor than hospital type. However, because of the small number of hospitals in this group, conditions in a single hospital might have influenced the results. Correlation on hospital and hospital ward levels were highest for Low frequency AE, indicating a stronger correlation for this outcome on these levels, and we cannot rule out that our findings are related to resources, patients' severity and nurses' perceptions of risk of complications[6]. We found that nurses working in *medical departments* gave poorer ratings of patients' self care ability and that *medical department* interacted with *index for patient mix*. We lack information about patients' severity and DRG-weights on departmental level, but the complexity in diseases and comorbidity among elderly patients' may explain this result if the majority of them are admitted to medical departments. These consideration do not explain why being affiliated to a *medical department* was associated with nurse-reported Patient safety, but may indicate that patient safety interventions are easier to apply and make visible in surgical departments as the procedures are more standardized[81].

Final remarks

The agreement of respondents within organisational levels (ICCs) was in accordance with similar studies reviewed by Park and Lake[82]. The culture of a group is formed by shared perceptions, thoughts and emotions, and a natural consequence is that the strongest correlation of nurses' assessments of organisational process variables was found at individual and hospital ward level[39].We conclude that organizational structure variables included in our study have minor impact on how nurses perceive work- and patient-related outcomes. However, the organizational process variables consistently related to all outcomes measures indicated that there is a considerable potential to address organizational design in improvement of patient safety and quality of care. This study makes a contribution to knowledge about how interventions should be targeted towards nurses as one major micro system of the organization. Further research should also address organisational processes relevant for other professions.

Ethical approvals: The method of data collection and handling was approved by the Data Protection Official for Research

Acknowledgements: The authors would like to thank all Norwegian nurses that responded on the nurse survey.

Competing interests: None

Funding: Data were collected by Norwegian Nurses' Organisation and Norwegian Knowledge Centre for the Health Services in collaboration. Christine Tvedt was supported by a grant from Norwegian Nurses' organisation.

Data sharing statement: The data set is available at The Norwegian Knowledge Centre for the Health Services, and requests should be addressed by emailing cht@nokc.no

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Title:

AN OBSERVATIONAL STUDY TO IDENTIFY ORGANIZATIONAL PROCESSES ASSOCIATED WITH NURSE-REPORTED QUALITY AND PATIENT SAFETY

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Key-words:

Patient safety, performance measures, nurses, survey, quality measurement.

Word count: 3788

ABSTRACT

Objectives: The purpose of this study was to identify organisational processes and structures that are associated with nurse-reported patient safety and quality of nursing. Health care workers' ~~attitudes and~~ perceptions related to patient safety vary by disciplines within the health care organisations, and organizational design promoting patient safety among nurses as a micro system of hospitals is studied~~, and nurses constitute a large proportion of health care workers. To target patient safety interventions it is vital to understand how nurses as a microsystem assess organisational structures and processes and relate them to patient safety.~~

~~-~~**Design**: This is ~~e present study is~~ an observational cross-sectional study using survey methods

Setting: Respondents from 31 ~~The multicenter study is conducted in 35~~ Norwegian hospitals with more than 85 beds were included in the survey.

Participants: All registered nurses working in direct patient care in a position of 20 % or more were invited to answer the survey. In this study 3618 nurses from surgical and medical wards responded (response rate 58.9). Nurses practice environment was defined as organisational processes and measured by the *Nursing Work Index Revised* and items from *Hospital Survey on Patient Safety Culture.*

Outcome measures: Nurses' assessments of patient safety, quality of nursing, confidence in how their patients manage after discharge and frequency of adverse events were used as outcome measures.

Results *Quality system*, *nurse-physician relation*, *patient safety management* and *staff adequacy* were process measures associated with nurse-reported work- and patient- related outcomes, but we found no associations with *nurse participation*, *education and career* and *ward leadership*. Most organisational structures were non-significant in the multilevel model

except for nurses' affiliations to *medical department* and *hospital type*. ~~Active programs to ensure quality, hospital management that encourage patient safety and having sufficient staff to provide quality of care were consistently related to how nurses perceive both work- and patient related outcome measures. Nurse physician relationship and working in a regional hospital gave higher ratings for work-related outcomes. Bed occupancy and nurse-patient ratio was positively associated with how nurses assessed patient related outcomes.~~

Conclusion Organisational structures may have minor impact on how nurses perceive work- and patient related outcomes, but the findings in this study indicate that there is a considerable potential to address organizational design in improvement of patient safety and quality of care.

Article focus

- Identifying organizational processes and structures associated to nurse-reported quality and patient safety in hospitals
- Increase knowledge about organizational design promoting patient safety among nurses as a micro system of hospitals

Key messages

- Organizational processes may have a considerable potential to address organizational design in improvement of patient safety and quality of care.

Strengths and limitations

- A considerable number of nurses have given their responses on a multicenter nurse survey providing a valuable data material.
- Several aspects of the survey method may have influenced the results of this study

AN OBSERVATIONAL STUDY TO IDENTIFY ORGANIZATIONAL PROCESSES ASSOCIATED WITH NURSE-REPORTED QUALITY AND PATIENT SAFETY

Introduction

The report "Crossing the quality chasm" from the Institute of medicine in 2001 called for a system change to improve safety in the health care services[1]. The report led to establishment of patient safety programmes and health care reforms in many Western countries. The introduction of evidence-based practice, guidelines, performance measurements, and feedback has characterized patient safety initiatives in hospitals during the last decade. ~~However, r~~Results from evaluations of the interventional~~se~~ efforts are inconsistent, and several authors have described a need to better understand how organizational features contribute to quality and patient safety in hospitals[2-4]. The organizational climate is defined by the employees' perceptions of these features, and might be understood as structural properties of the organisation and employees' perceptions of their organisational environment[5]. Both organizational structures (e.g. hospital size, hospital volume) and organisational processes (e.g. patient safety climate, perception of work environment) have been associated with safety outcomes[4-6].

The system perspective is based on how input to the health care system is managed and how this input benefits the patients and society [1]. ~~The underlying hypothesis of~~ Donabedian's model for quality serve as a framework to understand how ~~is that~~ hospital structures and processes contribute to health care outcomes and the model is modified by Battle et al to illustrate how processes exist within the structure of the healthcare system[7-9]. Battles describe how adjustments of organisational structures and processes may contribute to a reduction of failures that cause adverse events. An organisational climate where processes and structures allow patient safety improvements is required to minimize the failures of care[3,9]. Inertia of

organizational change observed in health care institutions is suggested as one explanation for why the "progress of patient safety improvements has been slow"[3]. A leadership with clear visions and strategies is a key to transformational change towards a patient safe organization, and[10] knowledge about how health care workers assess their work environment and patient safety in their work place should therefore be essential to these leaders[10].

~~There is~~The ~~a~~ growing body of evidence on how work environment is associated with ~~associations between organizational features and~~ healthcare performance support this view~~.~~. In studies of ~~P~~physicians' work environment ~~has been associated~~ associations with the quality of health service delivery have been presented and improvement of nurses' work environment is suggested as~~could be~~ a cost effective strategy to improve patient outcomes[11-15]. Several studies have presented associations between nurses' work environment and ~~Work environment for nurses has been associated with patient outcomes such as~~ patient outcomes like adverse events, risk-adjusted mortality and patient satisfaction[15-21]. These are important studies identifying associations between patient outcome and features of the health care organisation. However, information about how health care workers take advantage of processes and structures in the organization is essential for design of patient safe health care organisations[9,22,23].

Attitudes and perceptions related to patient safety vary by disciplines and micro systems. ~~, and t~~The planning and implementation of strategies and interventions to improve patient safety should take such variations into account[22,24-27]. ~~Donabedian's recognized approach to explore what is important in modern health care planning serves as framework for this study~~. Despite the fact that nurse-reported quality of care have been associated with failure to rescue, patient satisfaction and processes of care, a small number of studies has explored how nurse-reported

patient safety is associated with work environment[28 29 30-33]. ~~33~~ ~~Information about how individuals within the microsystems perceive and take advantage of processes and structures in the organization is vital for the design of patient safe health care institutions .may be explained by an inherence of values and traditions among health care workers that restrain the capacity for transformation[3].~~

Objectives

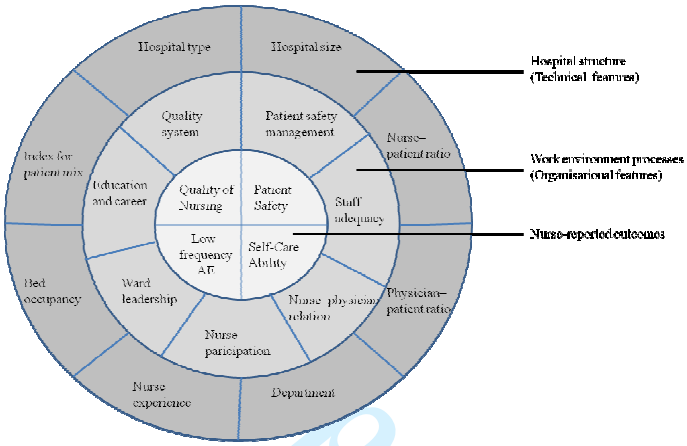
Nurses constitute a large proportion of health care workers, and how they perceive an organizational design promoting patient safety ~~may provide~~is essential information about nurses as a microsystem[4,8,34]. ~~.~~ The purpose of this study was to identify organisational process measures in nurses' work environment and hospital characteristics (organisational structure measures) that were associated with nurse-reported patient safety and quality of nursing. In particular, we were interested in which process measures remained after adjusting for organisational structure measures. ~~n the present investigation we study how nurses assess organisational features and relate them to patient safety and quality of nursing.~~

Methods

Design

The theoretical approach of this observational cross sectional study was based on Donabedian's dimensions of a quality model: structure, process and outcome. We modified Battles' version of this model to illustrate how hospital characteristics, nurses' work environment and nurse-reported quality of nursing and patient safety were nested (figure 1). The readers should bear in mind that these variables only represent part of a complex reality.

Figure 1 Modification of the Battles model to illustrate the nested relationship of structure, process and outcome [7]



and dData collection

This is observational cross-sectional study involves astudy involved a survey among nurses in surgical and medical wards in 35 Norwegian hospitals with more than 85 beds. The data collection was part of the European RN4Cast study[11]. A paper questionnaire, information letter, and return envelope were distributed through the nurses' union representatives to 6600 nurses during the autumn of 2009. Registered nurses working in direct patient care in a position of 20% or more were included, and nurses on long-term leaves were excluded. Nurses received the questionnaire at their workplaces, and the distribution procedures included collection of information about nurses' affiliations to hospital, department and ward. Personal reminders- were not distributed as- the respondents' names and addresses were not available to the researchers, and nowere distributed. In some hospital wards the union representatives and/or nurse leaders gave collective reminders. The method of data collection and handling was approved by the Data Protection Official for Research.

Nurse-reported outcome measures

The use of self-reported outcomes in this study was necessary to describe how nurses perceived quality of nursing and patient safety at their work places. ~~The dependent variables were based on nurses' responses to~~Single-item overall assessment of~~global questions about~~ quality of nursing and patient safety were used as outcome variables as practiced in ~~from the questionnaire.~~ other studies investigating nurse-reported quality and patient safety[30-33,35]. We defined the four questions as variables that describe ~~The outcomes were divided into two groups of which "~~ "work-related" referrings ~~to~~ how nurses ~~assess~~report work performance related to patient safety and "patient-related" referrings to nurses' ~~assessment~~reports of patient outcomes:

Work-related outcome measures

- Quality of Nursing: In general, how would you describe the quality of nursing care delivered to patients on your unit/ward? (four-point Likert-type scale where 1=poor, 2=fair, 3=good, and 5=excellent, meaning that high scores indicate better quality)
- Patient Safety: Please give your department an overall grade on patient safety. (5-point Likert-type scale where 1=failing, 2=poor, 3=acceptable, 4=very good, and 5=excellent, meaning that high scores indicate better Patient Safety~~)~~)

Patient-related outcome measures

- ~~Self-care ability~~Self-Care Ability: How confident are you that your patients are able to manage their care when discharged? (four-point Likert-type scale where 1=not at all confident, 2=somewhat confident, 3=confident, and 4=very confident, meaning that high scores indicate more confidence in how patients manage)

- Low Frequent AE: Nurses were also asked to estimate how frequently adverse events have happened to their patients on a seven-point Likert-type scale (1=~~every day~~never, 2=some times per ~~week~~year, 3=once a ~~week~~month or less, 4=some times per month, 5=once a ~~month or less~~week, 6=some times per ~~year~~week, 7= every day~~never~~). We recoded the subscale into the opposite direction so that the lowest frequency (Low frequency AE = preferably) made the highest scores.

Different types of adverse events where subjects of the question and in this study we calculated the mean of the seven adverse events scores per nurse:

- Pressure ulcers after admission
- Patients received wrong medication, time or dose
- Patient falls with injury
- Urinary tract infections
- Bloodstream infections
- Complaints from patients or their families
- Pneumonia

~~In the present study the different types of adverse events in question are summarized in a composite score for absence of nurse-reported adverse events (figure 1).~~

Organizational process measures

Nurses' work environment was measured by the instrument *Nursing Work Index* (NWI)[36] and a subscale including items from *The Hospital Survey on Patient Safety Culture* (HSOPSC)[37]. These- subscales were regarded as organizational processes and made the following variables:

- *Education and career*
- *Nurse participation*
- *Quality system*
- *Ward leadership*
- *Staff adequacy*
- *Nurse physician relation*

- *Patient safety management*

~~The nurses' work environment was measured by the practice environment scale of the *nursing work index revised* (PES-NWI). The instrument has been tested in different cultural contexts, and t~~The Norwegian version of ~~the PES-~~NWI has been translated and tested according to acknowledged procedures for questionnaire modifications between cultures[38]. We performed an exploratory analysis to identify the factor structure of the Norwegian dataset. The subscales identified were used as explanatory variables in the study.

The items were four-point Likert-type scales, and high scores indicated agreement that the items were present in the job situation ~~where~~ (1=strongly disagree, 2=somewhat disagree, 3=somewhat agree, and 4=strongly agree). The scale scores were calculated as the single items' average for all respondents who had valid scores on at least half of the items included in the scale in question., ~~and the scores were also linearly transformed from a 1-4 to a 0-100 scale.~~

Leadership is essential for development of organisational/patient safety culture, and we included three items from the HSOPSC-questionnaire[37,39,40]. ~~.~~ The items represent leadership topics such as performance feedback and actions showing that patient safety haves ~~s~~ priority in hospital management. ~~.~~ We regarded a subscale of these items as process measure for the work environment. High scores indicated agreement that the items were present in the job situation ~~The items were aggregated as a composite score~~ (five-point Likert-type scale: 1=strongly disagree, 2=disagree, 3=neither, 4=agree, 5=strongly agree). ~~.~~

Organizational structure measures

Information about the hospitals were collected from public registers, reported from hospital administrations on our request, or aggregated from the survey data[41,42]. The following ~~variables~~ measures were ~~defined~~ used as organizational structure ~~measures~~variables:

- *Nurse–patient ratio* (Number of nurse man-years per 10,000 patient days, 2009) [42]
- *Physician–patient ratio* (Number of physician man-years per 10,000 patient days, 2009) [42]
- *Index for patient mix* (The ratio between the number of DRG-points and the number of admissions, 2009)[41]
- *Hospital size* (Number of beds, 2009)[41]
- *Hospital type* (made as two dummy-variables):
  - *Regional university hospital* (~~versus~~ reference value: local hospital)
  - ~~Central~~ *Local university hospital* (~~versus~~ reference value: local hospital)
- *Bed occupancy* (mean bed occupancy in percent for 2009, hospital reported)
- *Medical department* (from the nurse survey: Nurses' affiliation to medical department with reference value: surgical department ~~versus surgical~~)
- *Nurse experience* (in years per hospital derived ~~(~~survey data~~nurse survey~~)

"*Regional university hospitals*" were defined as university hospitals with national responsibilities, while "*local university hospitals*" were defined as university hospitals without national responsibilities. All other hospitals were defined as "local hospitals". We collected organisational structure measures to ensure validity and comparability for all hospitals included in the survey. The measures selected for this study was chosen after considerations of literature discussing the context of patient safety research and practices. To describe and classify patient safety practices and research hospital type and size, patient clinical complexity, and professional staffing are suggested as essential structural

features[4,6,43,44 45]. ~~Theoretical considerations and the availability of data guided the selection of structure measures of the organizations. Based upon the results from an expert panel consensus on what features are important in order to evaluate patient safety interventions, we included variables that describe. All of these are~~

Statistical analysis

All analyses were made using SPSS version 15.0.

~~Principal axis factoring with promax rotation was used t~~We used exploratory factor analysis to examine the structure of NWI in the Norwegian dataset, involving~~o identify the factor structure of PES-NWI. Internal consistency was evaluated based on the complete Norwegian data set with nurses in~~ intensive care units, medical ~~wards,~~ and surgical wards (n=5490). We performed reliability tests to obtain internal consistency for these subscales and ~~Items scoring less than 0.3 were excluded. Correlations were made to compare the results with factor structures identified in other studies[36]. A reliability test was performed to test the consistency of the~~ for the subscale from HSOPSC ~~composite measure~~.

The questionnaire was distributed to 6147 nurses in medical and surgical wards, and 3618 responded (mean response rate: 58.9%). Based on recommendations for cut points for response rates we included 31 hospitals with a survey response rate above 40% [46]Nurses from intensive care units were excluded in the because the number of these units, the size, and the type of patients admitted vary between hospitals.. ~~In these hospitals t~~

Scores of outcome and explanatory variables were transformed into a 0–100 scale, 0 representing the lowest possible score and 100 the highest possible score. Organizational structure variables were transformed into variables relative to *hospital type* to control for the assumption of dependency with *hospital type* (in the following marked with "R" in variable

names). The transformation was made by subtracting the mean values of *hospital type* for each case. The unit of observation was individuals~~, and nurse characteristics are presented at an individual level.~~ . Descriptive statistics of organizational structure ~~and process~~ measures were made ~~on the~~at ~~-~~hospital-aggregated level.

Initially bivariate regression analysis for each organisational variable and each nurse-reported outcome was performed. In the stepwise multivariate regression that followed, all organisational variables ~~with all~~ and ~~possible~~all potential interactions were included. ~~in the model. Those i~~Main effects and interactions that remained significant on a 0.05 level were included in the ~~following analyses. in the~~ final multivariate multilevel regression introducing hospital ward and hospital as level 2 and 3 variables ~~model we Interactions~~. Interactions between *hospital type* and other structural variables were removed in the final model because they were related to features of single hospitals.

Results

The exploratory factor analysis identified six subscales from NWI, and internal consistency (Cronbach's alpha) ranged from 0.68 to 0.88 in the reliability test~~. ing gave, with *nurse participation* as the lowest and collegial *nurse physician relation* as the highest~~ (see table 1). Construction of the subscales and the subscales from PES-NWI[36] are presented ~~The items included in each subscale are shown~~ in figure 2 (online-only). Internal consistency (Cronbach's alpha) of the three items from HSOPSC was 0.72.

Table 1 Internal consistency (Cronbach's alpha) of subscales from NWI

Subscales	**Number of items**	**Internal consistency** (Cronbach's alpha)
Staff adequacy	3	0.80
Nurse physician relation	7	0.88
Ward leadership	4	0.78
Nurse participation	5	0.68
Education and career (possibilities)	4	0.73
Quality system	7	0.71

~~Pearson's correlations between the principal axis factoring of the Norwegian data and the original factor structure presented by Lake are shown in table 3 (online only)[36]. Reliability testing of the composite score made by three items from HSOPSC gave a Cronbach's alpha of 0.72.~~

The structural characteristics of hospitals ~~included in the survey~~ are described in table 2. Most of the hospitals were categorized as local (23), but three hospitals were ~~central~~ *local university hospitals* and another five were *regional university hospitals*.

Table2: Characteristics of the included hospitals (N=~~Organizational structure measures~~31)

Hospital characteristics	**Median**	**Min.–max.**
Hospital size[1)]	414	85–958
Index for patient mix[2)]	8.0	6.9–11.3
Physician–patient ratio[3)]	20.5	9.6–38.8
Nurse–patient ratio[4)]	53.3	29.9–82.9
Nurse experience (no. of years per hospital[5)])	8.6	4.1–13.3
Bed occupancy[6)]	87.3	75.2 –102.7

1) Number of beds 2) The ratio between the number of DRG-points and the number of admissions 3) Number of physician-years per 10,000 patient days 4) Number of nurse-years per 10,000 patient days 5) Mean years of experience among the respondents per hospital 6) Percent, bed occupancy for 2009

About 90 % of Norwegian nurses are members of NNO, and mean age among these nurses are 43, 90 % were female. The mean age of nurse respondents (N=3618) in this study~~the~~

survey was 35.6 (median 33, range 21–71), and their mean experience as nurses was 8.4 (median 5, range 0–45). Most nurses were female (93.8%). All registered nurses in Norway hold a Bachelor's degree, and 15.3% of the respondents had further education. The distribution of nurses between *hospital types* was 13.6% for central*local university* *hospital* and 29.2% for *regional**regional university* *hospital*. The distribution between departments was about even, with 56.4% of nurses working in medical departments.

Organizational process variables aggregated at hospital level are presented in table 3. The lowest scores were obtained for n*Nurse participation* and *staff adequacy* *had the lowest scores*, while agreement with *nurse-physician relation* and *ward leadership* *had high scores*was high.

Table 3 Nurses' assessment ofO organizational process measures (N=3618)

Hospital characteristics	**N**	**Median**	**Min.–max.**	**SD**
Patient safety management	3556	54.658.3	43.5 64.80-100	18.7
Staff adequacy	3602	44.344.4	25.4 61.30-100	22.4
Nurse-physician relation	3602	67.666.67	60.3 76.70-100	15.9
Education and career	3603	48.850.0	33.2 71.20-100	20.5
Quality system	3594	52.552.4	42.5 65.00-100	15.8
Nurse participation	3641	38.940.0	29.0 53.10-100	17.6
Ward leadership	3612	61.766.67	50.0 77.80-100	20.6

Bivariate linear regression showed that, with a few exceptions, organizational structure and process measures were associated with nurses' assessmentreports of Quality of Nursing, Patient Safety, Self-care abilitySelf-Care Ability, and Low-Frequent AELow frequency AE (see table 4, online only). The explanatory variables and interactions found significant in the stepwise model were analysed in a multivariatefinal - multivariate multilevel model introducing hospital ward and hospital as with level 2 and 3 variables, showed that almost all variance was found on individual level, and demonstrated that correlation among observations within the hospitals was lower than for hospital wards main effects of the interactions included (table 5). The correlation at hospital level accounted for 0.22 % – 0.74 % of the total

variance, and correlation at hospital ward level accounted for 2.46 % – 8.64 % of the total variance (table 5).

Table 5 Multivariate multilevel regression analysis of process/structure measures and nurses' self-reported work- and patient-related outcomes (N=3618)

		Work-related outcomes		Patient-related outcomes	
		Quality of Nursing	**Patient Safety**	**Self-Care Ability**	**Low frequency AE**
		Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)
Process measures	*Patient safety management*	0.0910 (<0.001)	0.1920 (<0.001)	0.134 (<0.001)	0.06 (<0.001)
	Staff adequacy	0.15-12 (<0.001)	0.123 (<0.001)	0.1012 (<0.001)	0.046 (<0.001)
	Nurse-physician relation	0.06 (0.0013)	0.076 (<0.001)	0.087 (0.00620)	
	Education and career				
	Quality system	0.25 (<0.001)	0.18 (<0.001)	0.201 (<0.001)	0.0910 (<0.001)
	Nurse participation	-0.054 (0.02811)			
	Ward leadership	0.054 (0.01134)			-0.035 (<0.0081)
Structure measures	*CentralLocal university hospital*				-3.082.44 (<0.0018)
	RegionalRegional university hospital	3.5745 (<0.0013)	1.892.12 (0.02402)	1.4871 (<0.375122)	
	Nurse–patient ratio-R			0.201 (0.127025)	
	Physician–patient ratio-R			-0.286 (0.290145)	
	Bed occupancy-R		0.001 (0.95505)	-0.250 (0.055160)	-0.098 (0.127007)
	Index for patient mix-R	0.010 (0.861994)		0.101 (0.415212)	
	Nurse experience-R			-0.7772 (0.07114)	0.337 (<0.05101)
	Hospital size-R			-0.02 (0.533446)	
	Medical department	0.2332 (0.769572)	-1.120.96 (0.03933)	-5.8948 (<0.001)	
Interactions	*Index for patient mix-R * Medical department*	0.142 (0.068114)		-0.28 (0.032)	
	*Nurse–patient ratio-R * nurse experience-R*			0.176 (<0.01301)	

	*Physician–patient ratio-R * nurse experience-R*			-0.287 (0.06606)	
	*Bed occupancy-R * Medical department*		-0.101 (0.227104)		
Intra class correlation	ICC hospital ward level (2) (percent)	5.68	2.46	5.35	8.64
	ICC hospital level (3) (percent)	0.56	0,72	0.22	0.74

The multivariate multilevel model showed that Nnurses' assessmentreports of work-related outcome measures;, Quality of Nursing, and Patient Safety, were associated with four of the organizational process measures; *patient safety management*, *staff adequacy*, *nurse–physician relation*, and *quality system* (table 5). For Quality of Nursing we found small but significant coefficients of *nurse participation* (negatively) and *ward leadership* (positively). We found positive associations between Working in a regional *regional university hospital* rather than a local hospital was associated with work-related outcome measures and. Nurses affiliated with to surgical *medical departments* gave lower higher ratings of Patient Safety than nurses working in medical surgical departments.

The patient-related outcome measures;, Self-care abilitySelf-Care Ability, and Low-Frequent AELow frequency AE, were associated with the organizational process measures *patient safety management*, *staff adequacy*-, and *quality system*. Self-Care Ability was associated with *Nurse-physician relation* (positively), and Low-Frequent AELow frequency AE was associated with *ward leadership* (negatively). variablesSelf-care Nurses working in a *medical department* reported poorer Self-Care Ability*medical department*. Nurses working a *local university hospital* rather than a local hospital reported higher frequency of adverse events (reduced Low-Frequent AELow frequency AE). The interactions included in the final model showed that *index for patient mix* reduced the negative effect of *medical department* on Self-

Care Ability. High *nurse experience* per hospital increased the effect of *nurse-patient ratio* on Self-Care Ability. Except for *medical department* none of the main effects involved in the interactions were significant.

~~Bed occupancy was negatively associated with patient outcomes, meaning that lower bed occupancy gave higher (better) ratings for patient outcomes.Working in a local versus central hospital gave higher ratings for Low-frequent AE~~Low frequency AE~~. Nurse experience was positively associated with Low-frequent AE~~Low frequency AE~~. We found a negative but marginal effect of ward leadership.Nurse–physician relationship and nurse–patient ratio were positively associated with self-care ability, and working in a surgical department gave higher ratings of self-care ability. Nurse experience-R was negatively associated with self-care ability. The positive effect of nurse–patient ratio was increased by lower nurse experience. The interaction between physician–patient ratio and nurse experience gave opposite results. Index for patient mix increased the effect of working in a surgical department.~~

Discussion

~~43~~Main findings

~~Our findings suggest that organizational processes are associated with both work- and patient-related outcome measures. Active programmes to ensure quality having sufficient staff to provide quality of care ((~~ Organisational process variables; *quality system, patient safety management, staff adequacy and nurse-physician relation* were associated with nurse-reported work- and patient- related outcomes. Not all process variables were associated with the outcomes. The organisational structure variables *medical department* and *hospital type* were associated with some of the nurse-reported outcomes.

Strengths and limitations

This study is based on data from one of the largest nurse surveys performed in Norway, and includes almost all Norwegian hospitals with more than 85 beds. Norwegian nurses give their workplaces better ratings of work environment and patient safety, and nurse-patient ratios are higher compared to other countries [11]. The good performance of Norwegian hospitals as assessed by nurses make it of particular interest to study the organisational design.

~~Methodological q~~Questions related to cross-sectional survey design are often addressed towards the inadequacy to prove causality. However, the intention of our study was not to add ~~proof~~ evidence of this kind, but to describe associations between ~~how~~ nurses' perceptions of work environment and their assessments of patient safety and quality of nursing. We have not made statistical controls to mitigate the risk of common method bias as the value of this is questioned[47-51]. The method for identifying the five-factor structure of nursing work index has been criticised, but is one of several ways to identify factor structure[52]. Internal consistency has been tested for both scales, and was higher for the six-factor structure identified in the present study and provided a nuanced description of work environment adapted to a Norwegian context [36 38]. ~~for exploratory provides a more nuanced description of processes in the work system~~The questionnaires were distributed through the nurses' union representatives, and we have not been able to control whether perspectives of NNO have influenced the results. ~~the survey results may have been affected by the distribution method.~~ The sample of this study is a relevant population with a response rate of 58.9%, and the age distribution is corresponding with studies of similar populations from Norway[53]. The difference in age from nurses in the NNO database may be explained by exclusion of nurses in leader positions and part-time positions. Nurses' practice environments are complex and cannot be fully covered by a questionnaire, but overall the nursing work index is characterised as a "promising instrument"[52,54]. However, NWI is developed to evaluate nurse-reported job

outcomes, and the applicability of the instrument to patient safety outcome might be uncertain[55]. Statistics Norway and The Norwegian Directorate of Health are well-established registers with complete coverage. The high quality of their data collection has minimized the risk of inaccuracy of organisational structure variables and ensured the comparability between hospitals.

~~*participation* This may have influenced the results, The exploratory factor analysis of PES-NWI on the Norwegian data specified six subscales that differed slightly from the five-subscale set identified in previous studies[35].were In the present studyobtained from the same questionnaire the survey design involves a risk of common method bias as all variables were.~~

Organisational process measures

Educational level has been associated with risk-adjusted patient mortality and failure to rescue within 30 days of admission[56,57]. Even though all Norwegian nurses hold a bachelor degree, we expected that *education and career* was associated with some of the outcome measures, but this was not the case. However, the association between *quality system*, involving issues as training for newly hired and continuity of nursing, and work- and patient- related outcomes ~~This~~ indicate that integrated training programmes are more important ~~than nurses' opportunities for individual professional development and career advancement when it comes to how they perceive~~ for patient safety and quality of nursing[57]. The subscale *quality system* also represents~~ing~~ continuous processes such as presence of quality control programmes, systems for documentation, and nursing versus medical orientation. These findings are supported in ~~a study from 1985 Haley~~studies showing that quality programmes influence health care workers attitudes and increase improvement events[58-61]. The existence of standards, infrastructure and quality systems ~~might~~ contribute to expectations and predictability for the health professionals and maximize their efforts to avoid patient harm

[1,9,62]. ~~found that the presence of an infection control programme was a cost-effective measure to prevent nosocomial and increase improvement events[32,33]The presence of routines and infrastructure related to information technology is critical for adequate documentation and coordination of care[1,7].~~. ~~supported the important patient outcomes studies, but does not take into account the skill-mix of Norwegian hospitals[44,45]. Our study showed an association between all outcome measures and t~~

The impact of nurse leadership and a management that prioritizes patient safety has been emphasised in several studies[10,40 63,64]. W*ard leadership* was inconsistently associated with the outcomes in this study, but the leadership aspect was supported by ~~-~~the subscale *patient safety management.* In a recent study the authors found that engaged leadership strengthened both communication and teamwork and that these qualities of the organisation enhanced patient safety[65]. Communication and collegial discussions are important aspects to streamline workflow and procedures to ensure patient safety, and serve as sources for professional development[66,67]. The association between good nurse-physician relation and high ~~-~~quality of care from other studies was supported in our findings~~is~~ [68-71]. The channels for communicating results from performance measurements and other patient safety messages require engagement from leaders on all levels, and should probably be formed by the preferences of the targeted health care profession.

~~involving discussion and feedback on adverse events and actions showing that patient safety has top priority[50,51]. The effects of audits and performance feedback on process have been confirmed in numerous studies, even though the results are et al. found that physicians rated institutional commitment to safety more positively than nurses did[23]. A possible explanation is that communication between hospital management and physicians functions more fluently. In our study patient safety management was associated with all outcome measures, which underlines the importance of well-functioning channels to communicate hospital~~

~~managements' engagement in patient safety to all health care professions. It is suggested that teamwork is fundamental to the administration of workflowdeployment of resources is essential to patient safety[66]. This is supported by our findings showing a significant association between work- and patient- related outcomes and the subscale *staff adequacy*. The subscale~~

Staff adequacy represent nurses' assessments of the possibility to get the work done, provide quality of care, and discuss problems related to care with colleagues. Processes that ensure adequate and targeted resource allocation may contribute to reduced length of stay, increase in ambulatory activity, as well as ensuring right competence at the right place and time[72 73]. Associations between staff ratios and patient outcomes such as failure to rescue, unplanned extubation, cardiac arrest, nosocomial infections, and risk-adjusted mortality have been found in several studies, indicating that staff levels are related to quality and patient safety[15,19,21,74-77]. Corresponding results have been shown in studies with nurse-reported outcome measures, but was not confirmed by our study[75-77]. A possible reason for this is that nurse-patient ratios are high in Norway and that Norwegian nurses perceive work environment better than nurses in other countries[11]. This may indicate that passing a threshold for staff levels, challenges related to quality, and patient safety could be met on an organizational level[11,23,78]. ~~[57-59]. The results are supported by international research suggesting thatThe Nurses' perceptions of staff adequacy were significant for all four outcome measures in the present study.. Adequate and targeted resource allocation can contribute to reduced length of stay, increase in ambulatory activity, as well as ensuring right competence at the right place and time[63]. In the present study nurse- patient ratio was only associated with self-care ability. Bed occupancy was associated with patient-related outcomes, indicating that workload has an impact on how nurses evaluate patient outcomes. In a qualitative study where hospital employees were invited to suggest patient safety interventions, increased staffing was ranked as the most~~

~~important measure[32]. The absence of relationships between nurse staffing and nurse-reported outcomes in our study may be explained by the high nurse-patient ratios in Norway compared to other countries.~~

~~In this study we found that nurses assess quality of nursing and patient safetyla higher in regional hospitals than in local hospitals, but this was not the case for nurse-assessed patient outcomes~~

Organisational structure measures

Most of the organizational structures were not significantly associated with outcome variables when hospital and hospital ward was introduced as levels in the analysis. Hence, when affiliation to regional university hospitals remained significant, it may as well be explained by a strong common perception of the hospital performance as of *hospital type*. *Regional university hospital* was not associated with~~The gap in results between work- and~~ nurse-reported ~~-~~patient-related outcomes implying that ~~may be explained by~~ nurses' perception of quality and safety may be good despite ~~the type of care delivered and~~ the risk for complications among patients in these hospitals. Associations between hospital type and patient safety indicators are inconsistently reported by other authors~~, and it is~~ that suggest~~ed~~ that features other than hospital type are more important for patient outcomes[6,79,80] ~~regional hospitals. Even though complications happen more often. However,~~

The negative association between ~~Low-Frequent AE~~Low frequency AE and *local university hospital* might confirm the assumption that common perception is a more decisive factor than hospital type. However, because of the small number of hospitals in this group, conditions in a single hospital might have influenced the results. Correlation on hospital and hospital ward levels were highest for ~~Low-Frequent AE~~Low frequency AE, indicating a stronger correlation

for this outcome on these levels, and we cannot rule out that our findings are related to resources, patients' severity and nurses' perceptions of risk of complications[6].

We found that nurses working in *medical departments* gave poorer ratings of patients' self care ability and that *medical department* interacted with *index for patient mix*. We lack information about patients' severity and DRG-weights on departmental level, but the complexity in diseases and comorbidity among elderly patients' may explain this result if the majority of them are admitted to medical departments. These consideration do not explain why being affiliated to a *medical department* was associated with nurse-reported Patient safety, but may indicate that patient safety interventions are easier to apply and make visible in surgical departments as the procedures are more standardized[81].

Final remarks

The agreement of respondents within organisational levels (ICCs) was in accordance with similar studies reviewed by Park and Lake[82]. The culture of a group is formed by shared perceptions, thoughts and emotions, and a natural consequence is that the strongest correlation of nurses' assessments of organisational process variables was found at individual and hospital ward level[39].

~~Conclusion~~We conclude that organizational structure variables included in our study have minor impact on how nurses perceive work- and patient-related outcomes. However, ~~the~~the organizational processe variables~~s~~ consistently related to all outcomes measures indicate~~d~~d that there is a considerable potential to address organizational design in improvement of patient safety and quality of care. This study makes a contribution to knowledge about how interventions should be targeted towards nurses as one major ~~microsystem~~micro system of the organization. ,Further research should also address organisational processes relevant for other professions.~~Our findings contribute to an undrstanding of how .~~

Ethical approvals: The method of data collection and handling was approved by the Data Protection Official for Research

Acknowledgements: The authors would like to thank all Norwegian nurses that responded on the nurse survey.

Competing interests: None

Funding: Data were collected by Norwegian Nurses' Organisation and Norwegian Knowledge Centre for the Health Services in collaboration. Christine Tvedt was supported by a grant from Norwegian Nurses' organisation.

Data sharing statement: The data set is available at The Norwegian Knowledge Centre for the Health Services, and requests should be addressed by emailing cht@nokc.no

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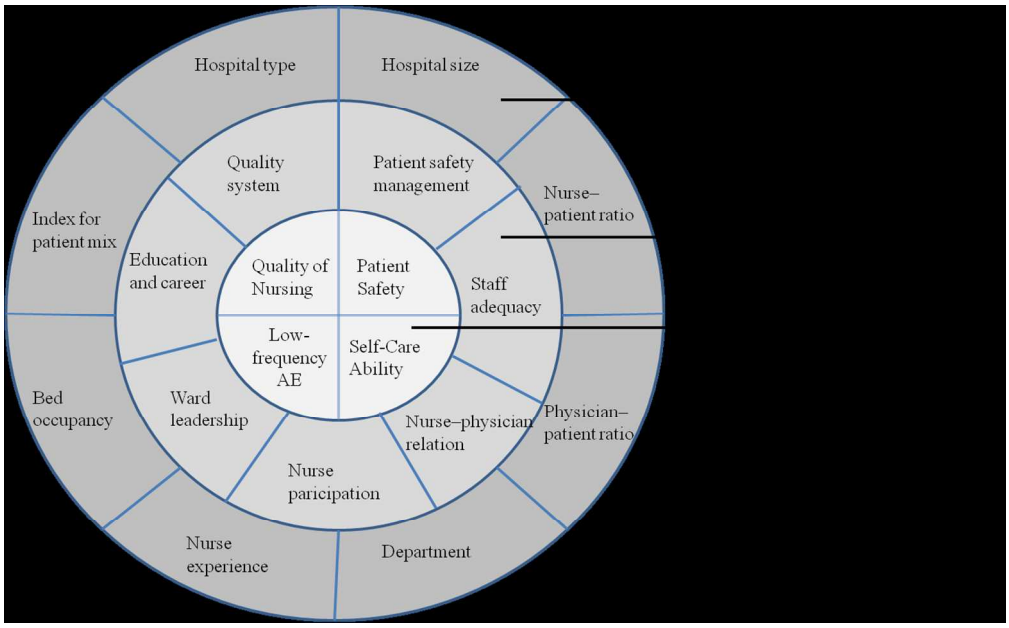

Modification of Battles' model to illustrate the understanding of structure, process and outcome in this context.
246x151mm (150 x 150 DPI)

Items of nursing work index	Six-factor structure of Norwegian dataset						Five-factor structure of Lake et al.				
	Education and career possibilities	Nurse participation in hospital affairs	Quality system	Ward leadership	Staff adequacy	Nurse physician relation	Nurse Participation in Hospital Affairs	Nursing Foundations for Quality of Care	Nurse Manager Ability, Leadership, and Support of Nurses	Staffing and Resource Adequacy	Collegial Nurse–Physician Relations
[illegible]											
[illegible]	[illegible]						[illegible]				
[illegible]	[illegible]								[illegible]		
[illegible]	[illegible]							[illegible]			
[illegible]	[illegible]						[illegible]				
[illegible]		[illegible]					[illegible]				
[illegible]		[illegible]					[illegible]				
[illegible]		[illegible]					[illegible]				
[illegible]		[illegible]					[illegible]				
[illegible]		[illegible]					[illegible]				
[illegible]		[illegible]					[illegible]				
[illegible]		[illegible]					[illegible]				
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[illegible]						[illegible]					[illegible]
[illegible]						[illegible]					[illegible]
[illegible]						[illegible]					[illegible]
Items of nursing work index that are not included in the Norwegiens questionnaire or											
[illegible]								[illegible]			
[illegible]								[illegible]			
[illegible]									[illegible]		
[illegible]										[illegible]	
[illegible]							[illegible]				

Comparison of PES-NWI and subscales identified from Norwegian data
232x276mm (96 x 96 DPI)

Figure 2 Subscales from the Norwegian (Norw) dataset and from the study of Lake (Lake)

Items of nursing work index	Six-factor structure of Norwegian dataset						Five-factor structure of Lake et al.				
	Education and career possibilities	Nurse participation in hospital affairs	Quality system	Ward leadership	Staff adequacy	Nurse physician relation	Nurse Participation in Hospital Affairs	Nursing Foundations for Quality of Care	Nurse Manager Ability, Leadership, and Support of Nurses	Staffing and Resource Adequacy	Collegial Nurse–Physician Relations
Included in the Norwegian version											
Career development clinical ladder opportunity	Norw						Lake				
A supervisory staff that is supportive of the nurses	Norw								Lake		
Active staff development or continuing education programs for nurses	Norw							Lake			
Opportunities for advancement	Norw						Lake				
Opportunity for staff nurses to participate in policy decisions		Norw					Lake				
A chief nursing officer who is highly visible and accessible to staff		Norw					Lake				
A chief nursing officer equal in power and authority to other top-level hospital executives		Norw					Lake				
Staff nurses are involved in the internal governance of the hospital (e.g., practice and policy committees)		Norw					Lake				
Staff nurses have the opportunity to serve on hospital and nursing committees		Norw					Lake				
A clear philosophy of nursing that pervades the patient care environment			Norw					Lake			
Working with nurses who are clinically competent			Norw					Lake			
An active quality assurance program			Norw					Lake			
A preceptor program for newly hired RNs			Norw					Lake			
Nursing care is based on a nursing, rather than a medical, model			Norw					Lake			
Written, up-to-date nursing care plans for all patients			Norw					Lake			
Patient care assignments that foster continuity of care, i.e., the same nurse cares for the patient from			Norw					Lake			
A nurse manager who is a good manager and leader				Norw					Lake		
Praise and recognition for a job well done				Norw					Lake		
A nurse manager who backs up the nursing staff in decision making, even if the conflict is with a				Norw					Lake		
Administration that listens and responds to employee concerns				Norw			Lake				
Enough time and opportunity to discuss patient care problems with other nurses					Norw					Lake	
Enough registered nurses to provide quality patient care					Norw					Lake	
Enough staff to get the work done					Norw					Lake	
Physicians and nurses have good working relationships						Norw					Lake
A lot of team work between nurses and physicians						Norw					Lake
Collaboration (joint practice) between nurses and physicians						Norw					Lake
Physicians value nurses' observations and judgments						Norw					Not incl.
Physicians recognize nurses' contributions to patient care						Norw					Not incl.
Physicians respect nurses as professionals						Norw					Not incl.
Physicians hold nurses in high esteem						Norw					Not incl.
Items of nursing work index that are not included in the Norwegiens questionnaire or											
Use of nursing diagnoses								Lake			
High standards of nursing care are expected by the administration								Lake			
Supervisors use mistakes as learning opportunities, not criticism									Lake		
Adequate support services allow me to spend time with my patients										Lake	
Nursing administrators consult with staff on daily problems and procedures							Lake				

Table 4 Univariate linear regression (online-only)

	Quality of nursing	**Patient safety**	**Self-care ability**	**Absence of adverse events**
	Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)
Patient safety management	0.29 (<0.001)	0.35 (<0.001)	0.30 (<0.001)	0.10 (<0.001)
Adequate staffing	0.29 (<0.001)	0.28 (<0.001)	0.26 (<0.001)	0.10 (<0.001)
Nurse physician relation	0.22 (<0.001)	0.22 (<0.001)	0.18 (<0.001)	0.06 (<0.001)
Education and career possibilities	0.24 (<0.001)	0.23 (<0.001)	0.20 (<0.001)	0.05 (<0.001)
Quality system	0.43 (<0.001)	0.41 (<0.001)	0.40 (<0.001)	0.14 (<0.001)
Nurse representation in hospital affairs	0.25 (<0.001)	0.25 (<0.001)	0.23 (<0.001)	0.06 (<0.001)
Ward leadership	0.25 (<0.001)	0.25 (<0.001)	0.23 (<0.001)	0.04 (<0.001)
Nurse-patient ratio	0.17 (<0.001)	0.17 (<0.001)	0.29 (<0.001)	0.05 (0.013)
Physician-patient ratio	0.24 (<0.001)	0.15 (0.006)	0.29 (0.002)	-0.21 (0.607)
Central hospital	-1.74 (0.045)	-2.92 (<0.001)	-0.69 (0.582)	-2.98 (<0.001)
Regional hospital	3.92 (<0.001)	2.33 (<0.001)	4.43 (<0.001)	-0.28 (0.498)
Mean occupancy	-0.18 (<0.001)	-0.17 (<0.001)	-0.16 (<0.001)	-0.16 (<0.001)
Index for patient mix	0.17 (<0.001)	0.13 (<0.001)	0.13 (0.005)	0.02 (0.393)
Mean nurse experience	0.39 (0.005)	-0.44 (<0.001)	-0.67 (0.001)	0.34 (<0.001)
Hospital size	-0.09 (0.419)	-0.09 (<0.001)	-0.11 (<0.001)	-0.04 (<0.001)
Medical specialty (vs surgical)	1.26 (0.037)	0.24 (0.642)	-4.46 (<0.001)	-0.14 (0.719)

Figure 2. Items included in factors identified by principal axis factoring

Education and career possibilitites	Career development/clinical ladder opportunity
	A supervisory staff that is supportive of the nurses
	Active staff development or continuing education programs for nurses
	Opportunities for advancement
Nurse participation in hospital affairs	Opportunity for staff nurses to participate in policy decisions
	A chief nursing officer who is highly visible and accessible to staff
	A chief nursing officer equal in power and authority to other top-level hospital executives
	Staff nurses are involved in the internal governance of the hospital (e.g., practice and policy committees)
	Staff nurses have the opportunity to serve on hospital and nursing committees
Quality system	A clear philosophy of nursing that pervades the patient care environment
	Working with nurses who are clinically competent
	An active quality assurance program
	A preceptor program for newly hired RNs
	Nursing care is based on a nursing, rather than a medical, model
	Written, up-to-date nursing care plans for all patients
	Patient care assignments that foster continuity of care, i.e., the same nurse cares for the patient from one day to the next
Ward leadership	A nurse manager who is a good manager and leader
	Praise and recognition for a job well done
	A nurse manager who backs up the nursing staff in decision making, even if the conflict is with a physician
	Administration that listens and responds to employee concerns
Staff adequacy	Enough time and opportunity to discuss patient care problems with other nurses
	Enough registered nurses to provide quality patient care
	Enough staff to get the work done
Nurse physician relation	Physicians and nurses have good working relationships
	A lot of team work between nurses and physicians
	Collaboration (joint practice) between nurses and physicians
	Physicians value nurses' observations and judgments
	Physicians recognize nurses' contributions to patient care
	Physicians respect nurses as professionals
	Physicians hold nurses in high esteem

Dear editor

Dear reviewers

Oslo 20/10/12

We are most grateful for the profound and useful comments from the reviewers of the manuscript "AN OBSERVATIONAL STUDY TO IDENTIFY ORGANIZATIONAL PROCESSES ASSOCIATED WITH NURSE-REPORTED QUALITY AND PATIENT SAFETY".

We believe the reviewer comments have contributed to a considerable improvement of the manuscript. The revised version has undergone major changes and we have responded to the comments through rewriting large parts of the manuscript.

We have systematized the reviewer comments in a table and hope to upload this file to facilitate the reading during the resubmission process. In case this is not possible, our responses is also found below as plain text.

We hope you find the changes interesting and relevant, and look forward to hear from you.

Best regards Christine Tvedt

On behalf of all authors.

Reviewer Diane Doran

Rev No	Recommendations	My specifications	Status
D1	More information needs to be provided about the accuracy of data obtained from public registers. How reliable are the data about structural characteristics of hospitals and was any attempt made to validate the data? Some of the variables are not adequately explained such as nurse patient ratio and physician-patient ratio. Was this an average across all types of programs, both inpatient and outpatient? What specifically is index for patient mix?	a) Comment on reliability and validity of data from public registers.	Commented in discussion (page 20)
		b) Explain nurse and physician to patien ratios i metode	Specified in methods page 11
		c) Explain index for patient mix i metode	Specified in methods page 12

D2	It would also be helpful to have data on the representativeness of the nurse sample to the general population of nurses in Norway in order to inform the external validity of the study. The average age seems young compared to what I am familiar with.	a) Comment on nurse sample to general population of nurses, especially age	Commented in methods page 14 and discussion page 19
D4	The investigators aggregated data on organizational process measures to the hospital level. They should report the intra-class correlation coefficient. None of the tables have sample size reported.		Sample size is included in tables, and organisational process measures are analysed at individual level. See page 15, table 3
D5	Are we to infer there were no missing cases for any variables or were missing values imputed? It would be helpful to clearly identify which variables in table 3 represent the Lake set of variables and which are from the current study.	a) Missing	Methods page 10
		b) Lakes subscales	See online-figure number 2

Reviewer: Greta G. Cummings

Revision number	Recommendations	My specifications	Status
C1	Abstract – the objectives section is not written as objectives. It should be revised to more clearly identify the purpose of the study and the specific objectives.	Rewrite abstract	See abstract page 2
C2	Additional detail about sample size etc should be added to the methods.	Rewrite abstract	See abstract page 2
C3	The conclusions are not clear and grammatical issues throughout may it difficult to understand exactly what the authors are intending. For example, "… there is a considerable potential to address organizational design to improve of nurses' assessments of patient safety" does not tell the reader if the authors are recommending that organisational designs could or should be changed (and how this would be done), and whether nurses' "ability to assess patient safety" or their actual assessment scores?	Rewrite abstract	See abstract page 2
C4	Manuscript - the confusion about the actual purpose and objectives is evident here as well. The purpose type statement indicates that the authors study "how nurses assess organizational features and relate them to patient safety and quality of nursing". This is somewhat different than the abstract, and does not delineate what aspects of nursing (care, outcomes?, performance?).	a) Introduction: specify objectives and purpose of the study	See objectives page 6

C5	Literature – the literature review is very cursory and should be expanded to address more of the current safety literature including that which discusses the relationships between organizational characteristics, nurse reported outcomes and patient safety. The literature on patient safety cultures is also considerable and should be summarized as it relates to the researcher's operationalization of patient safety.	a) Introduction: expanded to address more of the current safety literature including that which discusses the relationships between organizational characteristics, nurse reported outcomes and patient safety	We have rewritten the introduction page 4 to respond to this
		b) The literature on patient safety cultures is also considerable and should be summarized as it relates to the researcher's operationalization of patient safety	We have rewritten the introduction page 4 to respond to this
C6	Donabedian's SPO framework is discussed in the literature review; however, the Structure, Process and Outcomes dimensions should be described in more detail and related to the concepts and measures of interest in this study. It is not clear if and how this model was used to guide the study design. Given the cross-sectional survey design, this analysis is limited by potential common method bias. It is important to identify potential relationships to be examined through the development of a priori hypotheses or research questions, and the efforts to mitigate common methods bias should be reported.	a) the Structure, Process and Outcomes dimensions should be described in more detail and related to the concepts and measures of interest in this study	We have rewritten the introduction page 4 to respond to this
		b) It is not clear if and how this model was used to guide the study design.	We have rewritten the introduction page 4 to respond to this
		c) efforts to mitigate common methods bias should be reported. I diskusjon?	Commented in discussion page 19
C7	Methods – The data collection procedures could be expanded somewhat. For example, it is not clear why Dillman-type methods were not used to send reminders.	a) hvorfor ikke påminnelser	Commented in methods page 7

C8	Measures – the rationale for using single items should be justified. Additionally the source of all measures must be reported along with reliability and validity information. The PES-NWI is not referenced (Lake et al). Despite reports of use, there is controversy about its use as measure of the nursing work environment (See Cummings et al, 2006 Nursing Research). If items were recoded, it should be noted (the NWI data are usually collected using a 4 point Likert scale of Strongly Agree=1 to strongly disagree =4, therefore requiring recoding.	a) Single items	Commented in methods page 8. Reference to PES-NWI is corrected. We beleive comments are responded to by rewriting methods
C9	Page 7 - What is the meaning of a composite score for the adverse events listed in Figure 1? Scale means? Added as a count variable?		See methods page 9
C10	Page 8 – how were the PES-NWI subscales and HSOPSC defined as organizational process measures – this needs to be justified. Similarly, the "theoretical considerations" related to the organizational structures measures need to be explained.		We beleive comments are responded to by rewriting introduction, objectives and methods
C11	The statistical analyses should also be justified. It is not clear why factor analysis was chosen. Given the number of hospitals and nurses in this study, the analyses could potentially be strengthened by testing hypotheses using a multilevel model. This would require aggregation of data to the care unit level. It would require ICC assessment however the literature has shown that culture and other organizational characteristics are unit or facility level characteristics and therefore should not be analyzed unadjusted across multiple facilities.		We have included hospital ward amd hospital in the model. See Statistical analysis and results
C12	Results –The relationships may be influenced by many other factors and without an analysis that controls for these, the relationships reported in the results are not as meaningful as if they based on a priori hypotheses as indicated earlier.		We have specified statistical methods and results to respond to these issues. The general rewriting should make this clearer
C13	Discussion – a considerable portion of the discussion repeats the results. The discussion would have to be reformulated once the rest of the manuscript has been revised.		Major changes in the discussion have been made as a consequence of the revisions of other parts of the manuscript

BMJ open

AN OBSERVATIONAL STUDY TO IDENTIFY ORGANIZATIONAL PROCESSES ASSOCIATED WITH NURSE-REPORTED QUALITY AND PATIENT SAFETY

Journal:	*BMJ Open*
Manuscript ID:	bmjopen-2012-001967.R2
Article Type:	Research
Date Submitted by the Author:	16-Nov-2012
Complete List of Authors:	Tvedt, Christine; Norwegian Knowledge Centre for the Health Services, Department of Quality Measurement and Patient Safety; University of Oslo, Institute of Health and Society Sjetne, Ingeborg; Norwegian Knowledge Centre for the Health Services Helgeland, Jon; The Norwegian Knowledge Centre for the Health Services, Department of Quality Measurement and Patient Safety Bukholm, Geir; Østfold Hospital Trust, Centre for Laboratory Medicine
Primary Subject Heading:	Health services research
Secondary Subject Heading:	Nursing
Keywords:	Organisation of health services < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Quality in health care < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Health & safety < HEALTH SERVICES ADMINISTRATION & MANAGEMENT

Title:

AN OBSERVATIONAL STUDY TO IDENTIFY ORGANIZATIONAL PROCESSES ASSOCIATED WITH NURSE-REPORTED QUALITY AND PATIENT SAFETY

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Key-words:

Patient safety, performance measures, nurses, survey, quality measurement.

Word count: 3797

ABSTRACT

Objectives: The purpose of this study was to identify organisational processes and structures that are associated with nurse-reported patient safety and quality of nursing. **Design**: This is an observational cross-sectional study using survey methods.

Setting: Respondents from 31 Norwegian hospitals with more than 85 beds were included in the survey.

Participants: All registered nurses working in direct patient care in a position of 20 % or more were invited to answer the survey. In this study 3618 nurses from surgical and medical wards responded (response rate 58.9). Nurses practice environment was defined as organisational processes and measured by the *Nursing Work Index Revised* and items from *Hospital Survey on Patient Safety Culture.*

Outcome measures: Nurses' assessments of patient safety, quality of nursing, confidence in how their patients manage after discharge and frequency of adverse events were used as outcome measures.

Results *Quality system*, *nurse-physician relation*, *patient safety management* and *staff adequacy* were process measures associated with nurse-reported work- and patient- related outcomes, but we found no associations with *nurse participation*, *education and career* and *ward leadership*. Most organisational structures were non-significant in the multilevel model except for nurses' affiliations to *medical department* and *hospital type*.

Conclusion Organisational structures may have minor impact on how nurses perceive work- and patient related outcomes, but the findings in this study indicate that there is a considerable potential to address organizational design in improvement of patient safety and quality of care.

Article focus

- Identifying organizational processes and structures associated to nurse-reported quality and patient safety in hospitals.
- Increase knowledge about organizational design promoting patient safety among nurses as a micro system of hospitals.

Key messages

- Addressing organisational design may have a considerable potential to improve patient safety and quality of care.

Strengths and limitations

- A considerable number of nurses have given their responses on a multicenter nurse survey providing a valuable data material.
- Several aspects of the survey method may have influenced the results of this study.

AN OBSERVATIONAL STUDY TO IDENTIFY ORGANIZATIONAL PROCESSES ASSOCIATED WITH NURSE-REPORTED QUALITY AND PATIENT SAFETY

Introduction

The report "Crossing the quality chasm" from the Institute of medicine in 2001 called for a system change to improve safety in the health care services[1]. The report led to establishment of patient safety programmes and health care reforms in many Western countries. The introduction of evidence-based practice, guidelines, performance measurements, and feedback has characterized patient safety initiatives in hospitals during the last decade. Results from evaluations of the interventional efforts are inconsistent, and several authors have described a need to better understand how organizational features contribute to quality and patient safety in hospitals[2-4]. The organizational climate is defined by the employees' perceptions of these features, and might be understood as structural properties of the organisation and employees' perceptions of their organisational environment[5]. Both organizational structures (e.g. hospital size, hospital volume) and organisational processes (e.g. patient safety climate, perception of work environment) have been associated with safety outcomes[4-6].

The system perspective is based on how input to the health care system is managed and how this input benefits the patients and society [1]. Donabedian's model for quality serve as a framework to understand how hospital structures and processes contribute to health care outcomes and the model is modified by Battle et al to illustrate how processes exist within the structure of the healthcare system[7-9]. Battles describes how adjustments of organisational structures and processes may contribute to a reduction of failures that cause adverse events. An organisational climate where processes and structures allow patient safety improvements is required to minimize the failures of care[3,9]. Inertia of organizational change observed in health care institutions is suggested as one explanation for why the "progress of patient safety improvements has been slow"[3]. A leadership with clear visions and strategies is a key to transformational change towards a patient safe organization, and knowledge about how health care workers assess their work environment and patient safety in their work place should therefore be essential to these leaders[10].

The growing body of evidence on how work environment is associated with healthcare performance support this view. In studies of physicians' work environment associations with the quality of health service delivery have been presented and improvement of nurses' work environment is suggested as a cost effective strategy to improve patient outcomes[11-15]. Several studies have presented associations between nurses' work environment and patient outcomes like adverse events, risk-adjusted mortality and patient satisfaction[15-21]. These are important studies identifying associations between patient outcome and features of the health care organisation. However, the way health care workers perceive and report patient safety serve as essential information to investigate how processes and structures support patient safe health care organisations [9,22,23].

A few studies emphasize the differences in how professions perceivepatient safety, and it may be useful to understand the attitudes and perceptions towards patient safety within professions[22,24-27]. The planning and implementation of strategies and interventions to improve patient safety may also take such variations into account. Despite the fact that nurse-reported quality of care have been associated with failure to rescue, patient satisfaction and processes of care, a small number of studies has explored how nurse-reported patient safety is associated with work environment[28 29 30-33].

Objectives

Nurses constitute a large proportion of health care workers, and how they perceive an organizational design promoting patient safety is essential information about nurses as a microsystem[4,8,34]. The purpose of this study was to identify organisational process measures in nurses' work environment and hospital characteristics (organisational structure measures) that

were associated with nurse-reported patient safety and quality of nursing. In particular, we were interested in which process measures remained after adjusting for organisational structure measures.

Methods

Design

The theoretical approach of this observational cross sectional study was based on Donabedian's dimensions of a quality model: structure, process and outcome. We modified Battles' version of this model to illustrate how we defined the placement of hospital characteristics, nurses' work environment and nurse-reported quality of nursing and patient safety (figure 1). The readers should bear in mind that these variables only represent part of a complex reality.

Figure 1 Modification of Battles' model to illustrate the understanding of structure, process and outcome in this context[7].

Data collection

This study involved a survey among nurses in surgical and medical wards in 35 Norwegian hospitals with more than 85 beds. The data collection was part of the European RN4Cast study[11]. A paper questionnaire, information letter, and return envelope were distributed through the nurses' union representatives to 6600 nurses during the autumn of 2009. Registered nurses working in direct patient care in a position of 20% or more were included, and nurses on long-term leaves were excluded. Nurses received the questionnaire at their workplaces, and the distribution procedures included collection of information about nurses' affiliations to hospital, department and ward. Personal reminders were not distributed as the

respondents' names and addresses were not available to the researchers. In some hospital wards the union representatives and/or nurse leaders gave collective reminders. The method of data collection and handling was approved by the Data Protection Official for Research.

Nurse-reported outcome measures

The use of self-reported outcomes in this study was necessary to describe how nurses perceived quality of nursing and patient safety at their work places. Single-item overall assessment of quality of nursing and patient safety were used as outcome variables as practiced in other studies investigating nurse-reported quality and patient safety[30-33,35]. We defined four items as variables that describe how nurses report work performance; "work-related measures", and how nurses describe patient outcomes, "patient-related measures":

Work-related outcome measures

- Quality of Nursing: In general, how would you describe the quality of nursing care delivered to patients on your unit/ward? (four-point Likert-type scale where 1=poor, 2=fair, 3=good, and 5=excellent, meaning that high scores indicate better quality)
- Patient Safety: Please give your department an overall grade on patient safety. (5-point Likert-type scale where 1=failing, 2=poor, 3=acceptable, 4=very good, and 5=excellent, meaning that high scores indicate better Patient Safety).

Patient-related outcome measures

- Self-Care Ability: How confident are you that your patients are able to manage their care when discharged? (four-point Likert-type scale where 1=not at all confident, 2=somewhat confident, 3=confident, and 4=very confident, meaning that high scores indicate more confidence in how patients manage).

- Low Frequent AE (Adverse Events): Nurses were also asked to estimate how frequently adverse events have happened to their patients on a seven-point Likert-type scale (1=never, 2=some times per year, 3=once a month or less, 4=some times per month, 5=once a week, 6=some times per week, 7= every day). We recoded the subscale into the opposite direction so that the lowest frequency (Low frequency AE = preferably) made the highest scores.

Different types of adverse events were subjects of the question and in this study we calculated the mean of the seven adverse events scores per nurse:

- Pressure ulcers after admission
- Patients received wrong medication, time or dose
- Patient falls with injury
- Urinary tract infections
- Bloodstream infections
- Complaints from patients or their families
- Pneumonia

Organizational process measures

Nurses' work environment was measured by the instrument *Nursing Work Index* (NWI)[36] and a subscale including items from *The Hospital Survey on Patient Safety Culture* (HSOPSC)[37]. These variables were regarded as organizational processes and made the following variables:

- *Education and career*
- *Nurse participation*
- *Quality system*
- *Ward leadership*
- *Staff adequacy*
- *Nurse physician relation*
- *Patient safety management*

The Norwegian version of NWI was translated and tested according to acknowledged procedures for questionnaire modifications between cultures[38]. We performed an exploratory factor analysis to identify the factor structure of the Norwegian dataset. The subscales identified were used as explanatory variables in the study.

The items were four-point Likert-type scales, and high scores indicated agreement that the features were present in the job situation (1=strongly disagree, 2=somewhat disagree, 3=somewhat agree, and 4=strongly agree). The scale scores were calculated as the single items' average for all respondents who had valid scores on at least half of the items included in the scale in question.

Leadership is essential for development of organisational/patient safety culture[37,39,40]. Three items from the HSOPSC-questionnaire represented leadership topics such as performance feedback and actions showing that patient safety have priority in hospital management. We regarded a subscale of these items as process measure for the work environment. High scores indicated agreement that the items were present in the job situation (five-point Likert-type scale: 1=strongly disagree, 2=disagree, 3=neither, 4=agree, 5=strongly agree).

Organizational structure measures

Information about the hospitals were collected from public registers, reported from hospital administrators on our request, or aggregated from the survey data[41,42]. The following measures were used as organizational structure variables:

- *Nurse–patient ratio* (Number of nurse man-years per 10,000 patient days, 2009) [42]
- *Physician–patient ratio* (Number of physician man-years per 10,000 patient days, 2009) [42]

- *Index for patient mix* (The ratio between the number of DRG-points and the number of admissions, 2009)[41]
- *Hospital size* (Number of beds, 2009)[41]
- *Hospital type* (made as two dummy-variables):
    - *Regional university hospital* (reference value: local hospital)
    - *Local university hospital* (reference value: local hospital)
- *Bed occupancy* (mean bed occupancy in percent for 2009, hospital reported)
- *Medical department* (from the nurse survey: Nurses' affiliation to medical department with reference value: surgical department)
- *Nurse experience* (in years per hospital derived from survey data)

"*Regional university hospitals*" were defined as university hospitals with national responsibilities, while "*local university hospitals*" were defined as university hospitals without national responsibilities. All other hospitals were defined as "local hospitals". We collected organisational structure measures to ensure validity and comparability for all hospitals included in the survey. The measures selected for this study was chosen after considerations of literature discussing the context of patient safety research and practices. To describe and classify patient safety practices and research hospital type and size, patient clinical complexity, and professional staffing are suggested as essential structural features[4,6,43,44 45].

Statistical analysis

All analyses were made using SPSS version 15.0.

We used exploratory factor analysis to examine the structure of NWI in the Norwegian dataset, including nurses working in intensive care units, medical and surgical wards (n=5490). We performed reliability tests to assess internal consistency for the NWI and for the subscale from HSOPSC.

The questionnaire was distributed to 6147 nurses in medical and surgical wards, and 3618 responded (mean response rate: 58.9%). Based on recommendations for cut points for response rates we included 31 hospitals with a survey response rate above 40%[46]. Nurses from intensive care units were excluded because the number of these units, the size, and the type of patients admitted vary between hospitals.

The values of all variables' were transformed into a 0–100 scale, 0 representing the lowest possible score and 100 the highest possible score. Organizational structure variables were transformed into variables relative to *hospital type* to control for the assumption of dependency with *hospital type* (in the following marked with "R" in variable names). The transformation was made by subtracting the mean values of *hospital type* for each case. The unit of observation was individuals. Descriptive statistics of organizational structure measures were made at hospital-aggregated level.

Initially bivariate regression analysis for each organisational variable and each nurse-reported outcome was performed. In the stepwise multivariate regression that followed, all organisational variables and all potential interactions were included. Main effects and interactions that remained significant on a 0.05 level were included in the final multivariate multilevel regression introducing hospital ward and hospital as level 2 and 3 variables. Interactions between *hospital type* and other structural variables were removed in the final model because they were related to features of single hospitals.

Results

The exploratory factor analysis identified six subscales from NWI, and internal consistency (Cronbach's alpha) ranged from 0.68 to 0.88 in the reliability test (see table 1). A comparison of the subscales we identified and the subscales from PES-NWI[36] is presented in figure 2. Internal consistency (Cronbach's alpha) of the three items from HSOPSC was 0.72.

Table 1 Internal consistency (Cronbach's alpha) of subscales

Subscales	Number of items	Internal consistency (Cronbach's alpha)
Staff adequacy	3	0.80
Nurse physician relation	7	0.88
Ward leadership	4	0.78
Nurse participation	5	0.68
***Education and career* (possibilities)**	4	0.73
Quality system	7	0.71
Patient safety management	3	0.72

The structural characteristics of hospitals are described in table 2. Most of the hospitals were categorized as local (23), but three hospitals were *local university hospitals* and another five were *regional university hospitals*.

Table2: Characteristics of the included hospitals (N=31)

Hospital characteristics	Median	Min.–max.
Hospital size[1)]	414	85–958
Index for patient mix[2)]	8.0	6.9–11.3
Physician–patient ratio[3)]	20.5	9.6–38.8
Nurse–patient ratio[4)]	53.3	29.9–82.9
Nurse experience (no. of years per hospital[5)])	8.6	4.1–13.3
Bed occupancy[6)]	87.3	75.2 –102.7

1) Number of beds 2) The ratio between the number of DRG-points and the number of admissions 3) Number of physician-years per 10,000 patient days 4) Number of nurse-years per 10,000 patient days 5) Mean years of experience among the respondents per hospital 6) Percent, bed occupancy for 2009

About 90 % of Norwegian nurses are members of The Norwegian Nurses Organisation

(NNO). Mean age among the members of NNO are 43.0., and 90 % are female. The mean age of nurse respondents (N=3618) in this study was 35.6 (median 33.0, range 21–71), and their mean experience as nurses was 8.4 (median 5.0, range 0–45). Most nurses were female (93.8%). All registered nurses in Norway hold a Bachelor's degree, and 15.3% of the respondents had further education. The distribution of nurses between *hospital types* was 13.6% for *local university hospital* and 29.2% for *regional university hospital*. The distribution between departments was about even, with 56.4% of nurses working in medical departments.

Organizational process variables are presented in table 3. *Nurse participation* and *staff adequacy had the lowest scores*, while *nurse-physician relation* and *ward leadership* had high scores.

Table 3 Nurses' assessment of organizational process measures (N=3618)

Hospital characteristics	N	Median	Min.–max.	SD
Patient safety management	3556	58.3	0-100	18.7
Staff adequacy	3602	44.4	0-100	22.4
Nurse-physician relation	3602	66.67	0-100	15.9
Education and career	3603	50.0	0-100	20.5
Quality system	3594	52.4	0-100	15.8
Nurse participation	3641	40.0	0-100	17.6
Ward leadership	3612	66.67	0-100	20.6

Bivariate linear regression showed that, with a few exceptions, organizational structure and process measures were associated with nurses' reports of Quality of Nursing, Patient Safety, Self-Care Ability, and Low frequency AE (see table 4, online only). The final multivariate multilevel model introducing hospital ward and hospital as level 2 and 3 variables, showed that almost all variance was found on individual level, and demonstrated that correlation among observations within the hospitals was lower than for hospital wards (table 5). The correlation at hospital level accounted for 0.22 % – 0.74 % of the total variance, and

correlation at hospital ward level accounted for 2.46 % – 8.64 % of the total variance (table 5).

Table 5 Multivariate multilevel regression analysis of process/structure measures and nurses' self-reported work- and patient-related outcomes (N=3618)

		Work-related outcomes		Patient-related outcomes	
		Quality of Nursing	**Patient Safety**	**Self-Care Ability**	**Low frequencyAE**
		Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)
Process measures	*Patient safety management*	0.09 (<0.001)	0.19 (<0.001)	0.13 (<0.001)	0.06 (<0.001)
	Staff adequacy	0.12 (<0.001)	0.12 (<0.001)	0.10 (<0.001)	0.04 (<0.001)
	Nurse-physician relation	0.06 (0.003)	0.07 (<0.001)	0.08(0.006)	
	Education and career				
	Quality system	0.25 (<0.001)	0.18 (<0.001)	0.21 (<0.001)	0.09 (<0.001)

	Nurse participation	-0.04 (0.028)			
	Ward leadership	0.05 (0.011)			-0.03 (0.008)
Structure measures	*Local university hospital*				-3.08 (0.008)
	Regional university hospital	3.57 (0.003)	1.89 (0.024)	1.48 (<0.375)	
	Nurse–patient ratio-R			0.21 (0.127)	
	Physician–patient ratio-R			-0.28 (0.290)	
	Bed occupancy-R		0.00 (0.955)	-0.25 (0.055)	-0.09 (0.127)
	Index for patient mix-R	0.01 (0.861)		0.10 (0.415)	
	Nurse experience-R			-0.77(0.071)	0.33 (0.051)
	Hospital size-R			-0.02 (0.533)	
	Medical department	0.23 (0.769)	-1.12 (0.039)	-5.89 (<0.001)	
Interactions	*Index for patient mix-R * Medical department*	0.14 (0.114)		-0.28 (0.032)	
	*Nurse–patient ratio-R * nurse experience-R*			0.16 (0.013)	
	*Physician–patient ratio-R * nurse experience-R*			-0.28 (0.066)	
	*Bed occupancy-R * Medical department*		-0.10 (0.227)		
Intra class correlation	ICC(percent)/design effect (hospital ward level)	5.68/1.69	2.46/1.30	5.35/1.65	8.64/2.05
	ICC(percent)/design effect (hospital level)	0.56/1.47	0,72/1.61	0.22/1.19	0.74/1.62

Intraclass correlation coefficients and design effects for each outcome are presented in table 5. The multivariate multilevel model showed that nurses' reports of work-related outcome measures; Quality of Nursing, and Patient Safety, were associated with four of the organizational process measures; *patient safety management*, *staff adequacy*, *nurse–physician relation*, and *quality system* (table 5). Small but significant coefficients were found for associations between Quality of Nursing and *nurse participation* (negatively) and *ward leadership* (positively).Working at a *regional university hospital* rather than at a local hospital was associated with both work-related outcome measures. Nurses affiliated to *medical departments* gave lower ratings of Patient Safety than nurses working in surgical departments.

The patient-related outcome measures; Self-Care Ability, and Low frequency AE, were associated with the organizational process measures *patient safety management*, *staff adequacy*, and *quality system*. Self-Care Ability was associated with *Nurse-physician relation* (positively), and Low frequency AE was associated with *ward leadership* (negatively). Nurses working in a *medical department* reported poorer Self-Care Ability. Nurses working a *local university hospital* rather than a local hospital reported higher frequency of adverse events (reduced Low frequency AE). The interactions included in the final model showed that *index for patient mix* reduced the negative effect of *medical department* on Self-Care Ability. High *nurse experience* per hospital increased the effect of *nurse-patient ratio* on Self-Care Ability. Except for *medical department* none of the main effects involved in the interactions were significant.

Discussion

Main findings

Organisational process variables; *quality system, patient safety management, staff adequacy and nurse-physician relation* were associated with nurse-reported work- and patient- related outcomes. Not all process variables were associated with the outcomes. The organisational structure variables *medical department* and *hospital type* were associated with some of the nurse-reported outcomes.

Strengths and limitations

This study is based on data from one of the largest nurse surveys performed in Norway, and includes almost all Norwegian hospitals with more than 85 beds. Norwegian nurses give their workplaces better ratings of work environment and patient safety, and nurse-patient ratios are

high compared to other countries [11]. The good performance of Norwegian hospitals as assessed by nurses makes it of particular interest to study the organisational design.

Questions related to cross-sectional survey design are often addressed towards the inadequacy to prove causality. However, the intention of our study was not to add evidence of this kind, but to describe associations between nurses' perceptions of work environment and their assessments of patient safety and quality of nursing. We have not made statistical controls to mitigate the risk of common method bias as the value of this is questioned[47-51]. The method for identifying the five-factor structure of nursing work index has been criticised, but is one of several ways to identify factor structure[52]. Internal consistency has been tested for both scales, and was higher for the six-factor structure identified in the Norwegian data and provided a nuanced description of work environment and is likely better adapted to a Norwegian context [36 38]. The questionnaires were distributed through the nurses' union representatives, and we have not been able to control whether loyalty to NNO has influenced the results. The age distribution of our sample is corresponding with studies from similar populations in Norway, [53]. The difference in age from nurses in the NNO memberregister may be explained by exclusion of nurses in leader positions and part-time positions. Nurses' practice environments are complex and cannot be fully covered by a questionnaire, but overall the nursing work index is characterised as a "promising instrument"[52,54]. However, NWI is developed to evaluate nurse-reported job outcomes, and the applicability of the instrument to patient safety might be uncertain[55]. Statistics Norway and The Norwegian Directorate of Health are well-established registers with complete coverage. The high quality of their data collection has minimized the risk of inaccuracy of organisational structure variables and ensured the comparability between hospitals.

Organisational process measures

Educational level has been associated with risk-adjusted patient mortality and failure to rescue within 30 days of admission[56,57]. Even though all Norwegian nurses hold a bachelor degree, we expected that *education and career* was associated with some of the outcome measures, but this was not the case. However, the association between *quality system,* involving issues as training for newly hired and continuity of nursing, and work- and patient- related outcomes indicate that integrated training programmes may be more important for patient safety and quality of nursing[57]. The subscale *quality system* also represents continuous processes such as presence of quality control programmes, systems for documentation, and nursing versus medical orientation. These findings are supported in studies showing that quality programmes influence health care workers attitudes and increase improvement events[58-61]. The existence of standards, infrastructure and quality systems contribute to expectations and predictability for the health professionals and maximize their efforts to avoid patient harm [1,9,62].

In our study *Ward leadership* was inconsistently associated with the outcomes in this study. However, a positive association with *patient safety management* supports findings from studies that emphasise nurse leadership and a management that prioritizes patient safety[10,40 63,64]. In a recent study the authors found that engaged leadership strengthened both communication and teamwork and that these qualities of the organisation enhanced patient safety[65]. Communication and collegial discussions are important aspects to streamline workflow and procedures to ensure patient safety, and serve as sources for professional development[66,67]. The association between good nurse-physician relation and high quality of care from other studies was supported in our findings[68-71]. The channels for communicating results from performance measurements and other patient safety messages require engagement from leaders on all levels, and should probably be customized to preferences of the targeted health care profession.

Staff adequacy represent nurses' assessments of the possibility to get the work done, provide quality of care, and discuss problems related to care with colleagues. Processes that ensure adequate and targeted resource allocation may contribute to reduced length of stay, increase in ambulatory activity, as well as ensuring right competence at the right place and time[72 73]. Associations between staff ratios and patient outcomes such as failure to rescue, unplanned extubation, cardiac arrest, nosocomial infections, and risk-adjusted mortality have been found in several studies, indicating that staff levels are related to quality and patient safety[15,19,21,74-77]. Corresponding results have been shown in studies with nurse-reported outcome measures, but was not confirmed by our study[75-77]. A possible reason for this is that nurse-patient ratios are high in Norway and that Norwegian nurses perceive work environment better than nurses in other countries[11]. This may indicate that passing a threshold for staff levels, challenges related to quality, and patient safety could be met on an organizational level[11,23,78].

Organisational structure measures

Few organizational structure measures were significantly associated with outcome variables when hospital and hospital ward was introduced as levels in the analysis. Hence, when affiliation to regional university hospitals remained significant, it may as well be explained by a strong common perception of the hospital performance as of *hospital type*. *Regional university hospital* was not associated with nurse-reported patient-related outcomes implying that nurses' perception of quality and safety may be good despite the risk for complications among patients in these hospitals. Associations between hospital type and patient safety indicators are inconsistently reported by other authors that suggest that features other than hospital type are more important for patient outcomes[6,79,80].

The negative association between Low frequency AE and *local university hospital* might confirm the assumption that common perception is a more decisive factor than hospital type. However, because of the small number of hospitals in this group, conditions in a single hospital might have influenced the results. Correlation on hospital and hospital ward levels were highest for Low frequency AE, indicating a stronger correlation for this outcome on these levels, and we cannot rule out that our findings are related to resources, patients' severity and nurses' perceptions of risk of complications[6]. We found that nurses working in *medical departments* gave poorer ratings of patients' self care ability and that *medical department* interacted with *index for patient mix*. We lack information about patients' severity and DRG-weights on departmental level, but the complexity in diseases and comorbidity among elderly patients' may explain this result if the majority of them are admitted to medical departments. These consideration do not explain why being affiliated to a *medical department* was associated with nurse-reported Patient safety, but may indicate that patient safety interventions are easier to apply and make visible in surgical departments as the procedures are more standardized[81].

Final remarks

The agreement of respondents within organisational levels (ICCs) was in accordance with similar studies reviewed by Park and Lake[82]. The culture of a group is formed by shared perceptions, thoughts and emotions, and the dependency of the observations at ward level may be explained by such phenomena[39].

Organizational structure variables included in our study have minor impact on how nurses perceive work- and patient-related outcomes. However, the organizational process variables consistently related to all outcomes measures indicated that there is a considerable potential in adressing organizational design in improvement of patient safety and quality of care. This

study makes a contribution to knowledge about how interventions should be targeted towards organisational processes in patient safety work. Further research should also address organisational processes relevant for other professions.

Ethical approvals: The method of data collection and handling was approved by the Data Protection Official for Research.

Acknowledgements: The authors would like to thank all Norwegian nurses that responded on the nurse survey.

Competing interests: None.

Funding: Data were collected by Norwegian Nurses' Organisation and Norwegian Knowledge Centre for the Health Services in collaboration. Christine Tvedt was supported by a grant from Norwegian Nurses' organisation.

Data sharing statement: The data set is available at The Norwegian Knowledge Centre for the Health Services, and requests should be addressed by emailing cht@nokc.no**.**

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Title:

AN OBSERVATIONAL STUDY TO IDENTIFY ORGANIZATIONAL PROCESSES ASSOCIATED WITH NURSE-REPORTED QUALITY AND PATIENT SAFETY

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Key-words:

Patient safety, performance measures, nurses, survey, quality measurement.

Word count: 379788

ABSTRACT

Objectives: The purpose of this study was to identify organisational processes and structures that are associated with nurse-reported patient safety and quality of nursing. ~~Health care workers' perceptions related to patient safety vary by disciplines within the health care organisations, and organizational design promoting patient safety among nurses as a micro system of hospitals is studied~~

Design: This is an observational cross-sectional study using survey methods.

Setting: Respondents from 31 Norwegian hospitals with more than 85 beds were included in the survey.

Participants: All registered nurses working in direct patient care in a position of 20 % or more were invited to answer the survey. In this study 3618 nurses from surgical and medical wards responded (response rate 58.9). Nurses practice environment was defined as organisational processes and measured by the *Nursing Work Index Revised* and items from *Hospital Survey on Patient Safety Culture.*

Outcome measures: Nurses' assessments of patient safety, quality of nursing, confidence in how their patients manage after discharge and frequency of adverse events were used as outcome measures.

Results *Quality system*, *nurse-physician relation*, *patient safety management* and *staff adequacy* were process measures associated with nurse-reported work- and patient- related outcomes, but we found no associations with *nurse participation*, *education and career* and *ward leadership*. Most organisational structures were non-significant in the multilevel model except for nurses' affiliations to *medical department* and *hospital type*.

Conclusion Organisational structures may have minor impact on how nurses perceive work- and patient related outcomes, but the findings in this study indicate that there is a considerable

potential to address organizational design in improvement of patient safety and quality of care.

Article focus

- Identifying organizational processes and structures associated to nurse-reported quality and patient safety in hospitals.
- Increase knowledge about organizational design promoting patient safety among nurses as a micro system of hospitals.

Key messages

- Addressing organisational design ~~Organizational processes~~ may have a considerable potential ~~to address organizational design in~~to improve~~ment of~~ patient safety and quality of care.

Strengths and limitations

- A considerable number of nurses have given their responses on a multicenter nurse survey providing a valuable data material.
- Several aspects of the survey method may have influenced the results of this study.

AN OBSERVATIONAL STUDY TO IDENTIFY ORGANIZATIONAL PROCESSES ASSOCIATED WITH NURSE-REPORTED QUALITY AND PATIENT SAFETY

Introduction

The report "Crossing the quality chasm" from the Institute of medicine in 2001 called for a system change to improve safety in the health care services[1]. The report led to establishment of patient safety programmes and health care reforms in many Western countries. The introduction of evidence-based practice, guidelines, performance measurements, and feedback has characterized patient safety initiatives in hospitals during the last decade. Results from evaluations of the interventional efforts are inconsistent, and several authors have described a need to better understand how organizational features contribute to quality and patient safety in hospitals[2-4]. The organizational climate is defined by the employees' perceptions of these features, and might be understood as structural properties of the organisation and employees' perceptions of their organisational environment[5]. Both organizational structures (e.g. hospital size, hospital volume) and organisational processes (e.g. patient safety climate, perception of work environment) have been associated with safety outcomes[4-6].

The system perspective is based on how input to the health care system is managed and how this input benefits the patients and society [1]. Donabedian's model for quality serve as a framework to understand how hospital structures and processes contribute to health care outcomes and the model is modified by Battle et al to illustrate how processes exist within the structure of the healthcare system[7-9]. Battles describes how adjustments of organisational structures and processes may contribute to a reduction of failures that cause adverse events. An organisational climate where processes and structures allow patient safety improvements is required to minimize the failures of care[3,9]. Inertia of organizational change observed in health care institutions is suggested as one explanation for why the "progress of patient safety

improvements has been slow"[3]. A leadership with clear visions and strategies is a key to transformational change towards a patient safe organization, and knowledge about how health care workers assess their work environment and patient safety in their work place should therefore be essential to these leaders[10].

The growing body of evidence on how work environment is associated with healthcare performance support this view. In studies of physicians' work environment associations with the quality of health service delivery have been presented and improvement of nurses' work environment is suggested as a cost effective strategy to improve patient outcomes[11-15]. Several studies have presented associations between nurses' work environment and patient outcomes like adverse events, risk-adjusted mortality and patient satisfaction[15-21]. These are important studies identifying associations between patient outcome and features of the health care organisation. However, the way health care workers perceive and report patient safety serve as essential information to investigate how ~~information about how health care workers take advantage of~~ processes and structures support ~~in the organization is essential for design of~~ patient safe health care organisations [9,22,23].

A few studies emphasize the differences in how professions ~~Attitudes and~~ perceiveptions ~~related to~~ patient safety~~-~~, and it may be useful to understand the attitudes and perceptions towards patient safety within professions~~vary by disciplines and micro systems~~[22,24-27]. The planning and implementation of strategies and interventions to improve patient safety may alsoshould take such variations into account[22,24-27]~~.~~ . Despite the fact that nurse-reported quality of care have been associated with failure to rescue, patient satisfaction and processes of care, a small number of studies has explored how nurse-reported patient safety is associated with work environment[28 29 30-33].

Objectives

Nurses constitute a large proportion of health care workers, and how they perceive an organizational design promoting patient safety is essential information about nurses as a microsystem[4,8,34]. The purpose of this study was to identify organisational process measures in nurses' work environment and hospital characteristics (organisational structure measures) that were associated with nurse-reported patient safety and quality of nursing. In particular, we were interested in which process measures remained after adjusting for organisational structure measures.

Methods

Design

The theoretical approach of this observational cross sectional study was based on Donabedian's dimensions of a quality model: structure, process and outcome. We modified Battles' version of this model to illustrate how we defined the placement of hospital characteristics, nurses' work environment and nurse-reported quality of nursing and patient safety ~~were nested~~ (figure 1). The readers should bear in mind that these variables only represent part of a complex reality.

Figure 1 Modification of Battles' model to illustrate the understanding of structure, process and outcome in this context[7].

Data collection

This study involved a survey among nurses in surgical and medical wards in 35 Norwegian hospitals with more than 85 beds. The data collection was part of the European RN4Cast

study[11]. A paper questionnaire, information letter, and return envelope were distributed through the nurses' union representatives to 6600 nurses during the autumn of 2009. Registered nurses working in direct patient care in a position of 20% or more were included, and nurses on long-term leaves were excluded. Nurses received the questionnaire at their workplaces, and the distribution procedures included collection of information about nurses' affiliations to hospital, department and ward. Personal reminders were not distributed as the respondents' names and addresses were not available to the researchers. In some hospital wards the union representatives and/or nurse leaders gave collective reminders. The method of data collection and handling was approved by the Data Protection Official for Research.

Nurse-reported outcome measures

The use of self-reported outcomes in this study was necessary to describe how nurses perceived quality of nursing and patient safety at their work places. Single-item overall assessment of quality of nursing and patient safety were used as outcome variables as practiced in other studies investigating nurse-reported quality and patient safety[30-33,35]. We defined ~~the~~ four ~~questions~~ items as variables that describe how nurses report work performance; "work-related measures", and how nurses describe patient outcomes, "patient-related measures":

Work-related outcome measures

- Quality of Nursing: In general, how would you describe the quality of nursing care delivered to patients on your unit/ward? (four-point Likert-type scale where 1=poor, 2=fair, 3=good, and 5=excellent, meaning that high scores indicate better quality)
- Patient Safety: Please give your department an overall grade on patient safety. (5-point Likert-type scale where 1=failing, 2=poor, 3=acceptable, 4=very good, and 5=excellent, meaning that high scores indicate better Patient Safety).

Patient-related outcome measures

- Self-Care Ability: How confident are you that your patients are able to manage their care when discharged? (four-point Likert-type scale where 1=not at all confident, 2=somewhat confident, 3=confident, and 4=very confident, meaning that high scores indicate more confidence in how patients manage).
- Low Frequent AE (Adverse Events): Nurses were also asked to estimate how frequently adverse events have happened to their patients on a seven-point Likert-type scale (1=never, 2=some times per year, 3=once a month or less, 4=some times per month, 5=once a week, 6=some times per week, 7= every day). We recoded the subscale into the opposite direction so that the lowest frequency (Low frequency AE = preferably) made the highest scores.

Different types of adverse events where subjects of the question and in this study we calculated the mean of the seven adverse events scores per nurse:

- Pressure ulcers after admission
- Patients received wrong medication, time or dose
- Patient falls with injury
- Urinary tract infections
- Bloodstream infections
- Complaints from patients or their families
- Pneumonia

Organizational process measures

Nurses' work environment was measured by the instrument *Nursing Work Index* (NWI)[36] and a subscale including items from *The Hospital Survey on Patient Safety Culture* (HSOPSC)[37].

These ~~subscales~~ variables were regarded as organizational processes and made the following variables:

- *Education and career*
- *Nurse participation*
- *Quality system*
- *Ward leadership*
- *Staff adequacy*
- *Nurse physician relation*
- *Patient safety management*

~~.~~The Norwegian version of NWI ~~has been~~was translated and tested according to acknowledged procedures for questionnaire modifications between cultures[38]. We performed an exploratory factor analysis to identify the factor structure of the Norwegian dataset. The subscales identified were used as explanatory variables in the study.

The items were four-point Likert-type scales, and high scores indicated agreement that the ~~items~~ features were present in the job situation (1=strongly disagree, 2=somewhat disagree, 3=somewhat agree, and 4=strongly agree). The scale scores were calculated as the single items' average for all respondents who had valid scores on at least half of the items included in the scale in question.

Leadership is essential for development of organisational/patient safety culture~~, and we included three items from the HSOPSC-questionnaire~~[37,39,40]. Three items from the HSOPSC-questionnaire ~~The items~~ represented leadership topics such as performance feedback and actions showing that patient safety have priority in hospital management. We regarded a subscale of these items as process measure for the work environment. High scores indicated agreement that the items were present in the job situation (five-point Likert-type scale: 1=strongly disagree, 2=disagree, 3=neither, 4=agree, 5=strongly agree).

Organizational structure measures

Information about the hospitals were collected from public registers, reported from hospital administrations on our request, or aggregated from the survey data[41,42]. The following measures were used as organizational structure variables:

- *Nurse–patient ratio* (Number of nurse man-years per 10,000 patient days, 2009) [42]
- *Physician–patient ratio* (Number of physician man-years per 10,000 patient days, 2009) [42]
- *Index for patient mix* (The ratio between the number of DRG-points and the number of admissions, 2009)[41]
- *Hospital size* (Number of beds, 2009)[41]
- *Hospital type* (made as two dummy-variables):
    - *Regional university hospital* (reference value: local hospital)
    - *Local university hospital* (reference value: local hospital)
- *Bed occupancy* (mean bed occupancy in percent for 2009, hospital reported)
- *Medical department* (from the nurse survey: Nurses' affiliation to medical department with reference value: surgical department)
- *Nurse experience* (in years per hospital derived from survey data)

"*Regional university hospitals*" were defined as university hospitals with national responsibilities, while "*local university hospitals*" were defined as university hospitals without national responsibilities. All other hospitals were defined as "local hospitals". We collected organisational structure measures to ensure validity and comparability for all hospitals included in the survey. The measures selected for this study was chosen after considerations of literature discussing the context of patient safety research and practices. To

describe and classify patient safety practices and research hospital type and size, patient clinical complexity, and professional staffing are suggested as essential structural features[4,6,43,44 45].

Statistical analysis

All analyses were made using SPSS version 15.0.

We used exploratory factor analysis to examine the structure of NWI in the Norwegian dataset, including nurses working in intensive care units, medical and surgical wards (n=5490). We performed reliability tests to assess internal consistency for the NWI and for the subscale from HSOPSC.

The questionnaire was distributed to 6147 nurses in medical and surgical wards, and 3618 responded (mean response rate: 58.9%). Based on recommendations for cut points for response rates we included 31 hospitals with a survey response rate above 40%[46]. Nurses from intensive care units were excluded ~~in the~~ because the number of these units, the size, and the type of patients admitted vary between hospitals.~~.~~

The values of all variables' were transformed into a 0–100 scale, 0 representing the lowest possible score and 100 the highest possible score. Organizational structure variables were transformed into variables relative to *hospital type* to control for the assumption of dependency with *hospital type* (in the following marked with "R" in variable names). The transformation was made by subtracting the mean values of *hospital type* for each case. The unit of observation was individuals. Descriptive statistics of organizational structure measures were made at hospital-aggregated level.

Initially bivariate regression analysis for each organisational variable and each nurse-reported outcome was performed. In the stepwise multivariate regression that followed, all organisational variables and all potential interactions were included. Main effects and interactions that remained significant on a 0.05 level were included in the final multivariate multilevel regression introducing hospital ward and hospital as level 2 and 3 variables. Interactions between *hospital type* and other structural variables were removed in the final model because they were related to features of single hospitals.

Results

The exploratory factor analysis identified six subscales from NWI, and internal consistency (Cronbach's alpha) ranged from 0.68 to 0.88 in the reliability test (see table 1). A comparison of the subscales we identified and the subscales from PES-NWI[36] is presented in figure 2. Internal consistency (Cronbach's alpha) of the three items from HSOPSC was 0.72.

Table 1 Internal consistency (Cronbach's alpha) of subscales

Subscales	Number of items	Internal consistency (Cronbach's alpha)
Staff adequacy	3	0.80
Nurse physician relation	7	0.88
Ward leadership	4	0.78
Nurse participation	5	0.68
***Education and career* (possibilities)**	4	0.73
Quality system	7	0.71
Patient safety management	3	0.72

The structural characteristics of hospitals are described in table 2. Most of the hospitals were categorized as local (23), but three hospitals were *local university hospitals* and another five were *regional university hospitals*.

Table2: Characteristics of the included hospitals (N=31)

Hospital characteristics	Median	Min.–max.
Hospital size[1)]	414	85–958
Index for patient mix[2)]	8.0	6.9–11.3
Physician–patient ratio[3)]	20.5	9.6–38.8
Nurse–patient ratio[4)]	53.3	29.9–82.9
Nurse experience (no. of years per hospital[5)])	8.6	4.1–13.3
Bed occupancy[6)]	87.3	75.2 –102.7

1) Number of beds 2) The ratio between the number of DRG-points and the number of admissions 3) Number of physician-years per 10,000 patient days 4) Number of nurse-years per 10,000 patient days 5) Mean years of experience among the respondents per hospital 6) Percent, bed occupancy for 2009

About 90 % of Norwegian nurses are members of The Norwegian Nurses Organisation (NNO). ~~, and m~~Mean age among the members of NNO ~~these nurses~~ are 43.0., and 90 % ~~were~~ are female. The mean age of nurse respondents (N=3618) in this study was 35.6 (median 33.0, range 21–71), and their mean experience as nurses was 8.4 (median 5.0, range 0–45). Most nurses were female (93.8%). All registered nurses in Norway hold a Bachelor's degree, and 15.3% of the respondents had further education. The distribution of nurses between *hospital types* was 13.6% for *local university hospital* and 29.2% for *regional university hospital*. The distribution between departments was about even, with 56.4% of nurses working in medical departments.

Organizational process variables are presented in table 3. *Nurse participation* and *staff adequacy had the lowest scores*, while *nurse-physician relation* and *ward leadership* had high scores.

Table 3 Nurses' assessment of organizational process measures (N=3618)

Hospital characteristics	N	Median	Min.–max.	SD
Patient safety management	3556	58.3	0-100	18.7
Staff adequacy	3602	44.4	0-100	22.4
Nurse-physician relation	3602	66.67	0-100	15.9
Education and career	3603	50.0	0-100	20.5
Quality system	3594	52.4	0-100	15.8
Nurse participation	3641	40.0	0-100	17.6
Ward leadership	3612	66.67	0-100	20.6

Bivariate linear regression showed that, with a few exceptions, organizational structure and process measures were associated with nurses' reports of Quality of Nursing, Patient Safety, Self-Care Ability, and Low frequency AE (see table 4, online only). The final multivariate multilevel model introducing hospital ward and hospital as level 2 and 3 variables, showed that almost all variance was found on individual level, and demonstrated that correlation among observations within the hospitals was lower than for hospital wards (table 5). The correlation at hospital level accounted for 0.22 % – 0.74 % of the total variance, and correlation at hospital ward level accounted for 2.46 % – 8.64 % of the total variance (table 5).

Table 5 Multivariate multilevel regression analysis of process/structure measures and nurses' self-reported work- and patient-related outcomes (N=3618)

		Work-related outcomes		Patient-related outcomes	
		Quality of Nursing	**Patient Safety**	**Self-Care Ability**	**Low frequencyAE**
		Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)
Process measures	*Patient safety management*	0.09 (<0.001)	0.19 (<0.001)	0.13 (<0.001)	0.06 (<0.001)
	Staff adequacy	0.12 (<0.001)	0.12 (<0.001)	0.10 (<0.001)	0.04 (<0.001)
	Nurse-physician relation	0.06 (0.003)	0.07 (<0.001)	0.08(0.006)	
	Education and career				
	Quality system	0.25 (<0.001)	0.18 (<0.001)	0.21 (<0.001)	0.09 (<0.001)
	Nurse participation	-0.04 (0.028)			
	Ward leadership	0.05 (0.011)			-0.03 (0.008)
Structure measures	*Local university hospital*				-3.08 (0.008)
	Regional university hospital	3.57 (0.003)	1.89 (0.024)	1.48 (<0.375)	
	Nurse–patient ratio-R			0.21 (0.127)	
	Physician–patient ratio-R			-0.28 (0.290)	
	Bed occupancy-R		0.00 (0.955)	-0.25 (0.055)	-0.09 (0.127)
	Index for patient mix-R	0.01 (0.861)		0.10 (0.415)	
	Nurse experience-R			-0.77(0.071)	0.33 (0.051)
	Hospital size-R			-0.02 (0.533)	
	Medical department	0.23 (0.769)	-1.12 (0.039)	-5.89 (<0.001)	
Interactions	*Index for patient mix-R * Medical department*	0.14 (0.114)		-0.28 (0.032)	
	*Nurse–patient ratio-R * nurse experience-R*			0.16 (0.013)	
	*Physician–patient ratio-R * nurse experience-R*			-0.28 (0.066)	
	*Bed occupancy-R * Medical department*		-0.10 (0.227)		
Intra class correlation	ICC(percent)/design effect (hospital ward level)	5.68/1.69	2.46/1.30	5.35/1.65	8.64/2.05
	ICC(percent)/design effect (hospital level)	0.56/1.47	0,72/1.61	0.22/1.19	0.74/1.62

Intraclass correlation coefficients and design effects for each outcome are presented in table 5.

The multivariate multilevel model showed that nurses' reports of work-related outcome measures; Quality of Nursing, and Patient Safety, were associated with four of the

organizational process measures; *patient safety management*, *staff adequacy*, *nurse–physician relation*, and *quality system* (table 5). Small but significant coefficients were found for associations between Quality of Nursing and *nurse participation* (negatively) and *ward leadership* (positively).Working ~~in~~ at a *regional university hospital* rather than at a local hospital was associated with both work-related outcome measures. Nurses affiliated to *medical departments* gave lower ratings of Patient Safety than nurses working in surgical departments.

The patient-related outcome measures; Self-Care Ability, and Low frequency AE, were associated with the organizational process measures *patient safety management*, *staff adequacy*, and *quality system*. Self-Care Ability was associated with *Nurse-physician relation* (positively), and Low frequency AE was associated with *ward leadership* (negatively). Nurses working in a *medical department* reported poorer Self-Care Ability. Nurses working a *local university hospital* rather than a local hospital reported higher frequency of adverse events (reduced Low frequency AE). The interactions included in the final model showed that *index for patient mix* reduced the negative effect of *medical department* on Self-Care Ability. High *nurse experience* per hospital increased the effect of *nurse-patient ratio* on Self-Care Ability. Except for *medical department* none of the main effects involved in the interactions were significant.

Discussion

Main findings

Organisational process variables; *quality system, patient safety management, staff adequacy and nurse-physician relation* were associated with nurse-reported work- and patient- related outcomes. Not all process variables were associated with the outcomes. The organisational

structure variables *medical department* and *hospital type* were associated with some of the nurse-reported outcomes.

Strengths and limitations

This study is based on data from one of the largest nurse surveys performed in Norway, and includes almost all Norwegian hospitals with more than 85 beds. Norwegian nurses give their workplaces better ratings of work environment and patient safety, and nurse-patient ratios are high compared to other countries [11]. The good performance of Norwegian hospitals as assessed by nurses makes it of particular interest to study the organisational design.

Questions related to cross-sectional survey design are often addressed towards the inadequacy to prove causality. However, the intention of our study was not to add evidence of this kind, but to describe associations between nurses' perceptions of work environment and their assessments of patient safety and quality of nursing. We have not made statistical controls to mitigate the risk of common method bias as the value of this is questioned[47-51]. The method for identifying the five-factor structure of nursing work index has been criticised, but is one of several ways to identify factor structure[52]. Internal consistency has been tested for both scales, and was higher for the six-factor structure identified in the Norwegian data and provided a nuanced description of work environment and is likely better adapted to a Norwegian context [36 38]. The questionnaires were distributed through the nurses' union representatives, and we have not been able to control whether loyalty to NNO has influenced the results. The age distribution of our sample is corresponding with studies from similar populations in Norway, [53]. The difference in age from nurses in the NNO memberregister may be explained by exclusion of nurses in leader positions and part-time positions. Nurses' practice environments are complex and cannot be fully covered by a questionnaire, but overall the nursing work index is characterised as a "promising instrument"[52,54]. However, NWI is developed to

evaluate nurse-reported job outcomes, and the applicability of the instrument to patient safety might be uncertain[55]. Statistics Norway and The Norwegian Directorate of Health are well-established registers with complete coverage. The high quality of their data collection has minimized the risk of inaccuracy of organisational structure variables and ensured the comparability between hospitals.

Organisational process measures

Educational level has been associated with risk-adjusted patient mortality and failure to rescue within 30 days of admission[56,57]. Even though all Norwegian nurses hold a bachelor degree, we expected that *education and career* was associated with some of the outcome measures, but this was not the case. However, the association between *quality system,* involving issues as training for newly hired and continuity of nursing, and work- and patient- related outcomes indicate that integrated training programmes may be more important for patient safety and quality of nursing[57]. The subscale *quality system* also represents continuous processes such as presence of quality control programmes, systems for documentation, and nursing versus medical orientation. These findings are supported in studies showing that quality programmes influence health care workers attitudes and increase improvement events[58-61]. The existence of standards, infrastructure and quality systems contribute to expectations and predictability for the health professionals and maximize their efforts to avoid patient harm [1,9,62].

In our study *Ward leadership* was inconsistently associated with the outcomes in this study. However, a positive association with *patient safety management* supports findings from studies that emphasise nurse leadership and a management that prioritizes patient safety[10,40 63,64]. In a recent study the authors found that engaged leadership strengthened both communication and teamwork and that these qualities of the organisation enhanced patient safety[65]. Communication and collegial discussions are important aspects to streamline workflow and procedures to ensure patient safety, and serve as sources for professional

development[66,67]. The association between good nurse-physician relation and high quality of care from other studies was supported in our findings[68-71]. The channels for communicating results from performance measurements and other patient safety messages require engagement from leaders on all levels, and should probably be customized to preferences of the targeted health care profession.

Staff adequacy represent nurses' assessments of the possibility to get the work done, provide quality of care, and discuss problems related to care with colleagues. Processes that ensure adequate and targeted resource allocation may contribute to reduced length of stay, increase in ambulatory activity, as well as ensuring right competence at the right place and time[72 73]. Associations between staff ratios and patient outcomes such as failure to rescue, unplanned extubation, cardiac arrest, nosocomial infections, and risk-adjusted mortality have been found in several studies, indicating that staff levels are related to quality and patient safety[15,19,21,74-77]. Corresponding results have been shown in studies with nurse-reported outcome measures, but was not confirmed by our study[75-77]. A possible reason for this is that nurse-patient ratios are high in Norway and that Norwegian nurses perceive work environment better than nurses in other countries[11]. This may indicate that passing a threshold for staff levels, challenges related to quality, and patient safety could be met on an organizational level[11,23,78].

Organisational structure measures

Few organizational structure measures were significantly associated with outcome variables when hospital and hospital ward was introduced as levels in the analysis. Hence, when affiliation to regional university hospitals remained significant, it may as well be explained by a strong common perception of the hospital performance as of *hospital type*. *Regional*

university hospital was not associated with nurse-reported patient-related outcomes implying that nurses' perception of quality and safety may be good despite the risk for complications among patients in these hospitals. Associations between hospital type and patient safety indicators are inconsistently reported by other authors that suggest that features other than hospital type are more important for patient outcomes[6,79,80].

The negative association between Low frequency AE and *local university hospital* might confirm the assumption that common perception is a more decisive factor than hospital type. However, because of the small number of hospitals in this group, conditions in a single hospital might have influenced the results. Correlation on hospital and hospital ward levels were highest for Low frequency AE, indicating a stronger correlation for this outcome on these levels, and we cannot rule out that our findings are related to resources, patients' severity and nurses' perceptions of risk of complications[6]. We found that nurses working in *medical departments* gave poorer ratings of patients' self care ability and that *medical department* interacted with *index for patient mix*. We lack information about patients' severity and DRG-weights on departmental level, but the complexity in diseases and comorbidity among elderly patients' may explain this result if the majority of them are admitted to medical departments. These consideration do not explain why being affiliated to a *medical department* was associated with nurse-reported Patient safety, but may indicate that patient safety interventions are easier to apply and make visible in surgical departments as the procedures are more standardized[81].

Final remarks

The agreement of respondents within organisational levels (ICCs) was in accordance with similar studies reviewed by Park and Lake[82]. The culture of a group is formed by shared

perceptions, thoughts and emotions, and the dependency of the observations at ward level may be explained by such phenomena[39].

Organizational structure variables included in our study have minor impact on how nurses perceive work- and patient-related outcomes. However, the organizational process variables consistently related to all outcomes measures indicated that there is a considerable potential in adressing organizational design in improvement of patient safety and quality of care. This study makes a contribution to knowledge about how interventions should be targeted towards organisational processes in patient safety work~~nurses as one major micro system of the organization~~. Further research should also address organisational processes relevant for other professions.

Ethical approvals: The method of data collection and handling was approved by the Data Protection Official for Research.

Acknowledgements: The authors would like to thank all Norwegian nurses that responded on the nurse survey.

Competing interests: None.

Funding: Data were collected by Norwegian Nurses' Organisation and Norwegian Knowledge Centre for the Health Services in collaboration. Christine Tvedt was supported by a grant from Norwegian Nurses' organisation.

Data sharing statement: The data set is available at The Norwegian Knowledge Centre for the Health Services, and requests should be addressed by emailing cht@nokc.no.

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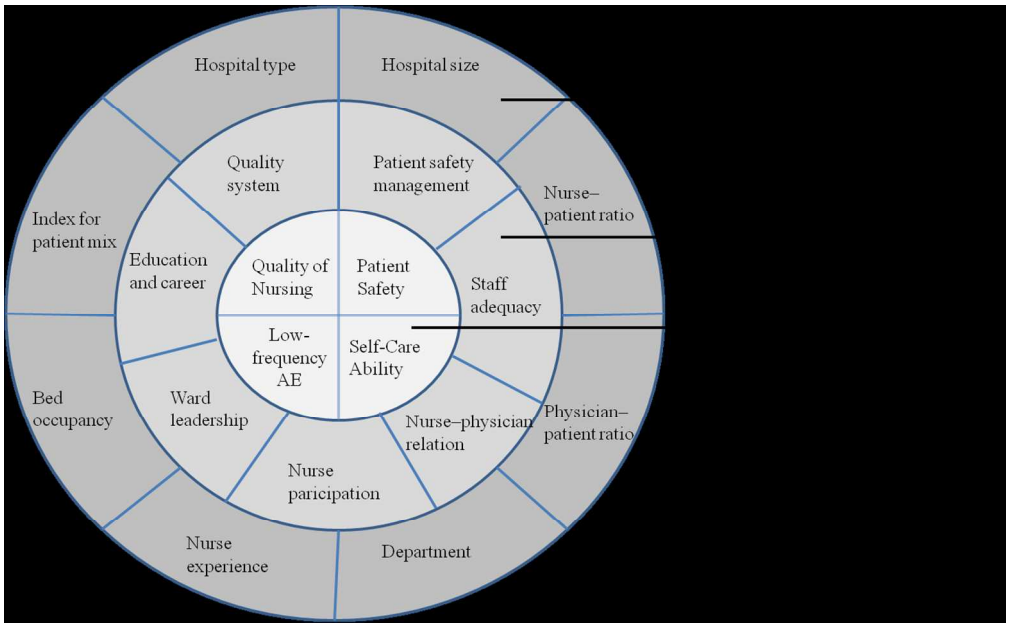

Modification of Battles' model to illustrate the understanding of structure, process and outcome in this context.
246x151mm (150 x 150 DPI)

Items of nursing work index	Six-factor structure of Norwegian dataset						Five-factor structure of Lake et al.				
	Education and career possibilities	Nurse participation in hospital affairs	Quality system	Ward leadership	Staff adequacy	Nurse physician relation	Nurse Participation in Hospital Affairs	Nursing Foundations for Quality of Care	Nurse Manager Ability, Leadership, and Support of Nurses	Staffing and Resource Adequacy	Collegial Nurse–Physician Relations
[illegible]											
[illegible]	Loads						Loads				
[illegible]	Loads								Loads		
[illegible]	Loads							Loads			
[illegible]	Loads						Loads				
[illegible]		Loads					Loads				
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Items of nursing work index that are not included in the Norwegiens questionnaire or											
[illegible]								Loads			
[illegible]								Loads			
[illegible]									Loads		
[illegible]										Loads	
[illegible]							Loads				

Comparison of PES-NWI and subscales identified from Norwegian data
232x276mm (96 x 96 DPI)

Table 4 Univariate linear regression (online-only)

	Quality of nursing	**Patient safety**	**Self-care ability**	**Absence of adverse events**
	Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)
Patient safety management	0.29 (<0.001)	0.35 (<0.001)	0.30 (<0.001)	0.10 (<0.001)
Adequate staffing	0.29 (<0.001)	0.28 (<0.001)	0.26 (<0.001)	0.10 (<0.001)
Nurse physician relation	0.22 (<0.001)	0.22 (<0.001)	0.18 (<0.001)	0.06 (<0.001)
Education and career possibilities	0.24 (<0.001)	0.23 (<0.001)	0.20 (<0.001)	0.05 (<0.001)
Quality system	0.43 (<0.001)	0.41 (<0.001)	0.40 (<0.001)	0.14 (<0.001)
Nurse representation in hospital affairs	0.25 (<0.001)	0.25 (<0.001)	0.23 (<0.001)	0.06 (<0.001)
Ward leadership	0.25 (<0.001)	0.25 (<0.001)	0.23 (<0.001)	0.04 (<0.001)
Nurse-patient ratio	0.17 (<0.001)	0.17 (<0.001)	0.29 (<0.001)	0.05 (0.013)
Physician-patient ratio	0.24 (<0.001)	0.15 (0.006)	0.29 (0.002)	-0.21 (0.607)
Central hospital	-1.74 (0.045)	-2.92 (<0.001)	-0.69 (0.582)	-2.98 (<0.001)
Regional hospital	3.92 (<0.001)	2.33 (<0.001)	4.43 (<0.001)	-0.28 (0.498)
Mean occupancy	-0.18 (<0.001)	-0.17 (<0.001)	-0.16 (<0.001)	-0.16 (<0.001)
Index for patient mix	0.17 (<0.001)	0.13 (<0.001)	0.13 (0.005)	0.02 (0.393)
Mean nurse experience	0.39 (0.005)	-0.44 (<0.001)	-0.67 (0.001)	0.34 (<0.001)
Hospital size	-0.09 (0.419)	-0.09 (<0.001)	-0.11 (<0.001)	-0.04 (<0.001)
Medical specialty (vs surgical)	1.26 (0.037)	0.24 (0.642)	-4.46 (<0.001)	-0.14 (0.719)