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Associations between Work Satisfaction, Engagement, and Seven-day Patient Mortality: a Cross-Sectional Survey

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Abstract

IMPORTANCE The clinical work environment and organizational culture can affect patient outcomes.

OBJECTIVE To evaluate the impact of professional roles and environmental work factors on the seven-day mortality of patients admitted with Acute Myocardial Infarction (AMI), stroke and hip fracture.

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DESIGN Results of a large cross-sectional validated survey of Norwegian hospital health care provider' work environment are linked to patient survival data.

SETTING 8,800 survey responses from physicians, nurses, and managers across 56 hospital wards within 20 hospitals over a three-year period (2010-2012).

PARTICIPANTS Data from 46,000 patients registered in the Norwegian Patient Registry (2010-2012) admitted with AMI, stroke and hip fracture were included.

MAIN OUTCOME AND MEASURES Seven-day mortality in all the 56 South Eastern Norway hospital wards in which AMI, stroke and hip fracture patients were treated.

RESULTS Nurse workload (Beta 0.019 (CI_{95} 0.009-0.028)) and middle manager engagement (Beta 0.024 (CI_{95} 0.010-0.037)) were associated with a case-mix adjusted seven-day patient mortality rates. A shift of one standard deviation in the workload scores for nurses or one standard deviation shift in the engagement scores for the hospital managers corresponds to a one percent shift in the patient mortality, corresponding to approximately 150 deaths a year in the studied population.

CONCLUSION AND RELEVANCE Seven-day mortality rates in hospital wards were negatively correlated with nurse workload and manager engagement. A deeper understanding of the relationships between patient outcomes, organizational structure, and their underlying cultural barriers may contribute to the development and implementation of effective and sustainable hospital system interventions to reduce adverse patient outcomes by improving the hospital work environments in which care is delivered.

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Strengths and limitations of this study

- This is the first study combining Norwegian staff survey data with patient mortality data.

- This study is strengthened by the use of ward-level data as hospital data might mask inter-ward differences.

- Patient data were case-mix adjusted, but not for the disease severity, thus it is hard to distinguish between patient who might die from the severity of their illness and less severe cases.

- This study included more than half of all Norwegian hospital, but still the number of wards is limited and prevented complex multivariate analysis.

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Hospitals are complex social-cultural organizations defined by their uncertainty and interdependency.[1] A strong linkage between the organization of care and patient outcomes has been found in several studies.[2,3] Complex organizations rely on rich inputs and interactions while they deliver an array of clinical services. In these settings, it can be hard to determine the proximal causes of an adverse patient event such as a cardiac arrest of a medication error.[4,5] Numerous initiatives have been promoted to enhance the quality of the patient's journey when in hospital, and yet at least one in ten patients still experiences adverse events.[6] High-reliability organizational theory posits that organizational features including psychological safety,[7] leadership involvement,[8] team based care ,[9] trusting support,[10] and a relentless culture of measurement are needed to sustain improvements in care.[11]

The impact of organizational culture on quality, reporting of data, and safety in non-medical organizations is well documented.[12-15] Monitoring staff perceptions of work environment and their organizational culture is used by managers to discover what is deemed meaningful and makes organizational sense to employees.[16,17] Leggat et al[18] have consistently demonstrated that a reported positive relationship between high-performance workplaces and organizational outcome also applies to patient outcomes in healthcare.[19]

Systems science and human factors engineering posit that focusing on the work environment and elements of organizational culture that support professionals' performance can reduce work hazards and enable safer outcomes.[20,21] In other words, organizational culture may be a fundamental determinant of patient outcomes.[22]

The objective of this study was to examine the impact of professional roles and the insidious influence of the organizational environment on seven-day patient outcomes.

METHODS

This cross-sectional study links survey data to concomitant patient demographic and outcome data derived from more than half of the patients in Norway with AMI, stroke and hip fracture among 56 Norwegian patient wards.

Setting and Study

We combined the 2010-2012 results of the annual South Eastern Norway Regional Health Authority staff surveys with seven-day patient mortality data from the same years to examine the association between staff reported work environment scores and patient mortality rates in hospitals. At the time of the study, the South Eastern Norway Regional

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Health Authority provided hospital care to 2.7 million inhabitants, nearly 56% of the Norwegian population of 4.9 million (2011).

Data from a three-year period (2010-2012) based on patients admitted with Acute Myocardial Infarction (AMI), stroke and hip fracture, and the work environment survey responses from physicians, nurses and middle managers were analyzed. The adjusted patient mortality rates were calculated by the Norwegian Institute of Public Health based on patient administrative data[23] and were linked to data from the annual work environment survey for nurses, doctors and middle managers.

Definitions and measurements of culture vary. For this study, we defined organizational culture as the behaviors that emerge based on shared values, beliefs, assumptions, and norms[12 13 24] Previous research demonstrated more variation in culture assessments between different clinical wards within the same hospital than between hospitals.[25] We used the ward level as our level of analyses, as previous studies have shown that data aggregated at hospital level may mask the unit differences.[26]

Selection of Hospitals

The hospitals included in the study varied in size and geographic catchment area, but had comparable organizational structures, with specially designated wards in each hospital caring for each of the three groups of patients. Patients admitted with a cerebral stroke were treated in stroke units according to national guidelines,[27] whereas most patients with a hip fracture were cared postoperatively in orthopedic wards. Patients with AMI underwent pre-hospital triage; patients with STEMI infarction are transported directly to PCI centers, whereas, patients with non-STEMI infarction are admitted to cardiac units at each of the respective hospitals.

Patient and Public Involvement

Patients were not involved in this study, but the results of this study were presented the Regional User Committee who supported the study design and its relevance.

Measurements

Survey Data: Work environment and patient safety culture

The web-based work environment and safety culture data were collected from 2010 to 2012. Nearly 50,000 questionnaires were distributed annually to all employees who had

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been employed for more than three months. Overall response rates for 2010, 2011, and 2012 were 72%, 77%, and 75%, respectively. Seventy-eight percent of the respondents defined their occupation as physician, nurse or middle manager. In total, 5,602 responses from nurses, 2,195 from physicians, and 1,036 from middle managers were included in the analysis. (Table 1)

Questionnaire

The South Eastern Norway work environment questionnaire is based on the highly credible General Nordic Questionnaire for Psychological and Social Factors at Work (QPSnordic), adapted and validated for healthcare, and supplemented with questions on patient safety culture.[28]   The survey instrument was designed to assess the local work environment and distinguish differences between hospital wards. The questionnaire has 57 items, measuring the work environment along 19 dimensions. (Table 2) Response alternatives are presented on a 5-point Likert scale (for some items "Strongly disagree", "Disagree", "Neither disagree nor agree", "Agree", "Strongly agree" or, where appropriate, "Never/very seldom", "Seldom", "Sometimes", "Quite often", "Very often/always"). The categories were assigned the values 0-25-50-75-100, assuming equal distance between scores.[29] The value zero reflects the highest burden/least favorable condition and the score 100 means the most positive rating (i.e., is coping/satisfied). The coding of negatively worded items was reversed to secure that higher code values always indicate a more positive response. For each of the 56-hospital study wards mean work environment scores and mean patient safety culture scores were calculated.

Clinical Data

Patient demographics

The average length of stay for the 46,026 patients was 8.1 days. The seven-day mortality rate varied from 2.8% - 7.7% for the included diagnosis. The mean Charlson Comorbidity Index scores was 1.5. (Table 3)

Seven-day patient mortality

All 46,026 emergency patients admitted with AMI, stroke, and hip fracture were included. Seven-day mortality rates were chosen instead of 30-day mortality rates, as a more

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extended observation period might confound the findings and include mortality unrelated to hospital characteristics, such as variations in post discharge care in local nursing homes and home healthcare services. The mortality rate was risk adjusted for age, gender, and the Charlson Comorbidity index scores based on these patients' admissions to hospital three years prior to admission, type of stroke (cerebral hemorrhage/cerebral infarct) and the total number of hospitalizations during the previous two years. In the event where a patient admission involved more than one hospital, the patient mortality probability was split, based on widely accepted methods, between the hospitals according to the fraction of time spent at each hospital to reduce possible bias.[30] [31] Diagnosis-specific mortality rates were calculated for all adult patients with the corresponding diagnoses; 17,734 patients admitted with first time Acute Myocardial Infarction (AMI) (ICD-10 I21.x), 14,442 cerebral stroke patients (ICD-10 I61.63.64), and 13,850 patients admitted over the age of 65 with a hip fracture (ICD-10 S72.0-2). The relative mortality rates were used as a comparable mortality rate for all hospital wards among the three diagnosis groups as follows:

$$Relative\ mortality\ rate_{unit} = \frac{\text{Mean mortality rate}_{patient\ group}\ -\ Mortality\ rate_{unit}}{\text{Mean mortality rate}_{patient\ group}}$$

Diagnosis-specific outcomes were aggregated over three years (2010-2012) to ensure adequate statistical power.

Statistical Analyses

The association between the ward work environment and adjusted ward patient mortality rates was analyzed using basic descriptive statistics examining for variation by linear regression. The effects of the different work environment factors were analyzed and reported separately, as the limited number of wards studied (n=56) prohibited including all explanatory variables in one single multiple predictive model. Backward regression was performed to ensure the reliability of our analysis. The work environment effects for physicians, nurses and middle managers were analyzed separately to assess how mortality is associated with work environment for the three separate professions. The statistical significance level was set at .05, and the 95% confidence intervals are presented below. All statistical analyses were carried out using the IBM SPSS statistical package Version 21.

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RESULTS

Objective 1: Examine the impact of professional roles and the insidious influence of the organizational environment on seven-day patient outcomes.

Fifty-six wards participated in this study. Staff, in general, rated their work environment positively on the 0-100 scale (100 indicating the most favorable condition): mean scores for nurses, physicians, and middle managers were 70.5, 67.2 and 76.3, respectively. Middle managers scored higher than physicians and nurses on all but three of the 19 organizational factors, while the nurses scored lower than managers and physicians on nine of the 19. The mean scores and standard deviation for each factor by profession are presented in Table 4.

Objective 2: Describe the Relation between Organizational Factors and Patient Mortality

Table 5 shows that several factors were significantly associated with patient mortality probabilities. The backward regression model demonstrated that a higher perceived workload by nurses was significantly associated with patient mortality: beta = 0.019 (0.009, 0.028). For middle managers, superior management engagement was the strongest predictor of seven-day mortality: beta= 0.027 (0.010, 0.044). No significant associations were found between physician work environment scores and patient mortality.

DISCUSSION

The major findings of this study are the associations between organizational work environment and seven-day patient mortality. Furthermore, our analysis show that aspects of the work environment at the 20 hospitals in the South Eastern Norway Health Region were significantly related to their documented seven-day mortality for patients admitted with AMI, stroke and hip fractures. We observed an increase in patient mortality in hospital units where nurses reported excessive workload and middle managers reported a lack of professional and organizational engagement by their superiors. No such associations were found between physician reported work environment and patient mortality. The strength of

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the reported associations indicates that a shift of one standard deviation in the workload

scores for nurses or one standard deviation shift in the engagement scores for the hospital

managers corresponds to a one percent shift in the patient mortality, corresponding to

approximately 150 deaths a year in the studied population.

Hospital staff scored their work environment positive (over 70) on a 0-100 scale (100

indicating the most favorable situation), consistent with the general satisfaction reported by

Norwegian employees who report higher job satisfaction than employees in other

countries.[32] However, there were profession-specific differences that may have contributed

to the observed variation in the patient outcomes across the 56 wards. Overall, the middle

managers scored higher than physicians and nurses, and nurses scored lowest on more

organizational factors than managers and physicians.

Whereas nurses typically worked at one hospital ward, physicians and middle

managers usually worked across several clinical units, and the assessment of their work

environment should be interpreted accordingly. We stress that it is not the physician or

manager perceptions of the patient ward that are being measured, but those of the work

environments of the wards where physicians and middle managers work (entire clinical

departments) supporting these patient wards.

Twelve of the 19 organizational environmental and workload factors scored by nurses

were significantly associated with seven-day patient mortality suggesting that the nursing

workload associated may be underappreciated.[33] The workload was the most prominent and

derived from survey items such as *"Is the physical load of your work too heavy?"*, *"Is your*

workload challenging?" and *"Do you perform work tasks for which you need more training?"*.

These survey items describe the nurse perceptions of their degree of control over the tasks

assigned to them. Our finding supports previous research suggesting that reducing nurse

workload may decrease patient mortality. [34-40]

As leaders, managers play a central role in building a positive and nurturing a

psychologically safe culture by setting norms and promoting shared *meanings* or shared

practices. [41 42] The middle managerial roles, situated between the senior leadership and

front-line workers, offers a unique vantage point from where strategies and policies can be

implemented. At the same time, middle managers are responsible for bringing staff

challenges and needs back to senior management for consideration and action. Managers

can contribute to organizational change by capitalizing on this position, [43] as management

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involvement and engagement have been suggested as a positive influence on care delivery systems. [8 44 45] At the same time, engagement of top-management and hospital boards in patient safety initiatives can enhance the middle managers' support for a safety culture that can, among other things, affect patient mortality.[46]

We did not find any correlation between patient mortality and physicians' perception of their work environment. The interpretation does not necessarily mean that physician work environment is unrelated to patient outcomes. We think this may be a result of physicians' sense of autonomy [47] and their responsibility covering patients in multiple departments and service lines simultaneously and this might affect their responses. For nurses the definition of work environment is more straightforward. Their work is generally restricted to one ward only, and they will have this ward in mind when responding to work surveys. Nurses report to, and are assigned tasks by, a supervisor on a daily basis; the same cannot be said for physicians who have much more autonomy about when and where their work takes place. This structural difference we believe can lead to a physician-as-manager philosophy and a nurse-as-employee philosophy in most healthcare organizations. Previous research has identified differences in culture and work styles within hospitals, and much of this variance was found to be located at the ward and microsystem levels.[48] The responses from physicians working on several wards may attenuate these inter-ward differences: their answers are based on their "average experiences" from several environments. This might explain the physician lack of significant association by hospital ward.

We chose to focus on mortality rates as our dependent variable as mortality is well-defined, easily measured, considered useful for estimating the effect of hospital care, [31 49] and "it matters a lot to patients".[50] Patient mortality rates in Norwegian hospitals and the variation between hospitals is lower than in other OECD countries.[51] However, some Norwegian hospitals have mortality rates significantly higher than the national average. Although a significant part of the variation seen in the observed hospital mortality can be explained by differences in the case mix and random variation, it has been suggested that 30-60% can be attributed to differences in the quality of patient care.[52] Some hospitals have structures and processes that minimize avoidable patient deaths better than others.[53] Studying these high performing hospitals can be valuable as they provide knowledge about the learning factors most important for organizational success and reliability.[54]

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Limitations

This study must be interpreted in the context of its design. First, the lack of detailed data available on the severity of the patient's illness at the time of their hospital admission. Our data was case-mix adjusted for age, gender, comorbidity, and the number of previous hospitalizations two years before the present admission, but not for the disease severity of each diagnosis. Accordingly, it is challenging to distinguish between patients who may have died from the severity of their illness and less severe cases, for whom the lack of high-quality care ultimately reduced their chances of survival.

Second, the study design did not allow linking of nurse, physician and middle manager' care culture evaluation to the survival of the individual patients under their care. That is, we were only able to relate the average staff evaluations to the average patient mortality for each unit. However, we addressed this by using a diagnosis-specific mortality rate that allowed us to link the work environmental perceptions to the hospital wards where the patients were most likely treated for their primary diagnosis. This afforded us the opportunity to dig deeper into our study dataset to examine the links between the work environment and patient outcomes as aggregated hospital data can mask the unit variation within each hospital. For physician however, their responses probably also reflected perceptive of work environments not connected to the patient population studied.

Third, culture evaluation surveys are susceptible to response bias at both the individual and ward respondent levels, but our response rate of 70-75% compares favorably with those of similar studies.[55] We believe that one should appeal to other methodologies (qualitative/ethnographic) as useful tools for exploring the informal work cultures of the high and low performing wards in our study.[56]
Another limitation is that only a small number of hospital wards were included in the study. The hospitals studied have nearly half of all Norwegian hospital beds, but Norway is a small country and the limited number of units prevent complex multivariate analyses, meaning that variables that could have explained parts of the mortality variation could not be controlled for. We therefore cannot rule out the possibility that the associations we observed may be non-causal correlations.

Finally, our study reflects the context and distinct constraints of the Norwegian healthcare delivery systems, which may be different from other healthcare systems.

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Norwegian employees generally perceive their work environment as more positive than staff in other countries,[32] and patient survival is relatively high,[51] but, the study probably carries relevance for the population as a whole, and to other countries, because it stems from a large and diverse sample of hospitals.

CONCLUSIONS

Our findings suggest a robust connection between organizational features of care delivery systems and bottom-line outcomes such as hospital mortality. Understanding these influences is critical to developing meaningful intervention strategies to improve patient outcomes and should be used in the planning of future work. Patients fare better in hospitals that are described as better places to work. Monitoring the work environment with robust metrics for psychological safety and engagement would benefit future investigations about the associations between organizational culture and patient outcomes, staff joy, and patient satisfaction.

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Table 1. Description of Survey Respondents by Age and Profession

	N	Age					Permanent employment	Female
		<30	30-39	40-49	50-59	60+		
Physician	2195	5.5%	40.7%	25.7%	17.9%	10.3%	68.9%	44.3%
Nurses	5602	15.3%	27.4%	26.2%	25.0%	6.1%	92.2%	90.9%
Managers	1036	0.7%	13.0%	33.7%	41.0%	11.6%	96.9%	68.1%

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Table 2. Work Environmental Factors and Culture Survey Items

Domain scales	Items
Goals	The unit goals are well known to all employees I know how I can contribute to the unit to reach its goals We regularly evaluate our achievements according to our goals
Improvement	In my unit, we do well in reporting and follow up on adverse events It is safe to report adverse events in my/this unit We openly discuss adverse events and learn from them In this unit, we encourage each other to think of ways to do things better
Quality	In my unit different professions collaborate well We work efficiently in my unit In my unit high quality is maintained
Patient-centered	In my unit, we listen to the views of patients/clients In my unit, we are available to patients/clients In my unit, sufficient information is given to patients/clients
Respect	In my unit, we respect patients/clients cultural background and religion In my unit, we comply to keep appointments made In my unit, we communicate clearly and in an understandable way
Motivation	Is your work challenging in a positive way My work tasks engage me The work is so interesting in itself that it is strongly motivating
Engagement	Do you look forward to going to work How often does dissatisfaction with your work make you want to change employer Overall, how satisfied are you with the work you do now
Commitment	To my friends, I praise this organization as a great place to work This organization inspires me to give my very best job performance I am proud of my workplace
Personal development	I can develop professionally through my work I get sufficient training and advice to do a good job Is your work organized in a way that lets you improve your abilities Do you get feedback about the quality of the work you do
Empowerment	Are you encouraged to participate in decision making Are you encouraged to speak up when you have a different opinion
Role expectations	Do you know what your responsibilities are Do you know what is expected of you at work
Social climate	Is the social climate in your unit characterized by a team spirit If needed, can you get support and help from your coworkers Do you perceive good collaboration in your unit
Conflicts and bullying	Have you observed anyone being harassed or bullied at your workplace during the last six months

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	Have you noticed disruptive conflicts in your unit
	When conflicts occur, are they handled in a professional manner
Workload	Is the physical load of your work too burdensome
	Is your work pace challenging
	Is your workload challenging
	Do you perform work tasks for which you need more training
Autonomy	Can you influence the amount of work assigned to you
	Can you set your own work pace
Role conflicts	Do you have to perform procedures which you feel should be done differently
	Are you given assignments without adequate resources to complete them
	Do you receive incompatible requests
Sick leave	Issues at work have contributed to my sick leaves during the last 12 months
Leadership	My immediate superior is available to me when I need it
	My immediate superior does an excellent job of giving us information about what goes on in our organization
	My immediate superior makes clear performance demands
	My immediate superior adheres to what we have agreed upon
	If I were subjected to violence or threats, I could count on the support of my immediate superior
	If I were sick for a more extended period, I could count on the support of my immediate superior
Patient safety culture	I would feel safe if I was a patient here
	Adverse medical events are appropriately handled here

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Table 3. Description of Patients and Clinical Outcomes

	Acute Myocardial infarction (first time)	Stroke	Hip fracture >65 years
Number of patients	17734	14442	13850
Number of admissions	17734	15235	14427
Death within 7 days, unadjusted	1234 (7.0%)	1180 (7.7%)	399 (2.8%)
Death within 30 days, unadjusted	2030 (11.4%)	2167 (14.2%)	1314 (9.1%)
Mean length of stay (days)	7.0	10.2	7.2
Treated in two or more hospitals	10412 (58.7%)	1915 (12.6%)	1252 (8.7%)
Gender, female	6785 (38.3%)	7297 (47.9%)	10297 (71.4%)
Age, mean	71.0	74.6	83.4
0-17 years	0 (0.0%)	0 (0.0%)	0 (0.0%)
18-49 years	1411 (8.0%)	777 (5.1%)	0 (0.0%)
50-75 years	8854 (49.9%)	6234 (40.9%)	2549 (17.7%)
>75 years	7469 (42.1%)	8224 (54.0%)	11878 (82.3%)
Number of previous hospitalization during last two years, mean	5.8	5.8	5.9
0	3786 (21.3%)	2432 (16.0%)	1652 (11.5%)
1	2799 (15.8%)	2181 (14.3%)	2069 (14.3%)
2	2189 (12.3%)	1914 (12.6%)	2008 (13.9%)
3-5	4130 (23.3%)	3922 (25.7%)	4142 (28.7%)
6+	4830 (27.2%)	4786 (31.4%)	4556 (31.6%)
Charlson comorbidity index, mean	1.5	1.3	1.8
0 points	8827 (49.8%)	8131 (53.4%)	5914 (41.0%)
1 points	1646 (9.3%)	1658 (10.9%)	1404 (9.7%)
2 points	3096 (17.5%)	2638 (17.3%)	3493 (24.2%)

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3+ points	4165 (23.5%)	2808 (18.4%)	3616 (25.1%)

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Table 4. Hospital Units Organizational Factor Score Averages by Professions (N=56)

	Nurse		Physician		Managers	
Measures	Mean	SD	Mean	SD	Mean	SD
Goals	62	7	63	9	72	8
Improvement	65	6	69	7	76	6
Quality and efficiency	77	6	77	8	78	8
Patient-centered	76	6	76	6	77	6
Respect for patients	74	4	74	6	76	6
Motivation	75	5	78	7	82	5
Engagement	76	7	75	8	81	7
Commitment	75	9	71	10	81	7
Personal development	62	7	63	8	70	9
Empowerment	55	6	60	9	74	9
Role expectations	89	3	85	6	88	5
Social interactions	83	6	79	8	81	7
Conflicts and bullying	75	5	73	9	81	7
Workload	52	9	54	7	62	7
Autonomy	39	7	38	7	46	9
Role conflicts	68	5	66	7	64	9
Sick leave	86	6	93	8	94	8
Leadership	74	9	75	9	77	12
Patient safety culture	78	8	85	7	90	7

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Table 5. Relationship between Organizational Factors and Patient Outcomes

Relative 7-day mortality (2010-2012) Diagnosis-specific*	Nurse unadjusted		Physician unadjusted		Managers unadjusted	
	Beta (95% CI)	p-value	Beta (95% CI)	p-value	Beta (95% CI)	p-value
Goals	0.008 (-0.006,0.022)	0.245	0.007 (-0.003,0.019)	0.204	0.009 (-0.003,0.021)	0.139
Improvement	0.011 (-0.005,0.027)	0.189	0.008 (-0.007,0.023)	0.305	0.012 (-0.004,0.027)	0.130
Quality	0.017 (-0.001,0.034)	0.057	0.004 (-0.008,0.016)	0.481	0.014 (0.001,0.027)	0.032
Patient centered	0.023 (0.007,0.039)	0.005	0.001 (-0.015,0.017)	0.882	0.014 (-0.001,0.030)	0.075
Respect	0.035 (0.013,0.057)	0.002	0.005 (-0.013,0.023)	0.577	0.015 (-0.002,0.031)	0.077
Motivation	0.024 (0.004,0.044)	0.022	-0.004 (-0.019,0.010)	0.53	0.028 (0.010,0.045)	0.002
Engagement	0.021 (0.007,0.036)	0.005	-0.006 (-0.019,0.008)	0.407	0.024 (0.010,0.037)	0.001
Commitment	0.015 (0.004,0.026)	0.009	-0.004 (-0.017,0.009)	0.537	0.018 (0.004,0.031)	0.010
Personal development	0.012 (-0.002,0.025)	0.094	-0.002 (-0.017,0.014)	0.826	0.018 (0.007,0.029)	0.001

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	Estimate (CI)	p	Estimate (CI)	p	Estimate (CI)	p
Empowerment	0.010 (-0.006,0.025)	0.231	0.000 (-0.012,0.011)	0.948	0.011 (0.001,0.022)	0.037
Role expectations	0.039 (0.004,0.074)	0.031	0.003 (-0.014,0.019)	0.750	0.011 (-0.008,0.031)	0.236
Social climate	0.012 (-0.006,0.030)	0.194	-0.008 (-0.020,0.004)	0.211	0.019 (0.006,0.031)	0.005
Conflicts and bullying	0.003 (-0.017,0.023)	0.765	-0.009 (-0.021,0.002)	0.111	0.010 (-0.005,0.026)	0.180
Work load	0.019 (0.009,0.028)	<0.001	-0.002 (-0.016,0.012)	0.742	0.018 (0.005,0.031)	0.006
Autonomy	0.021 (0.006,0.035)	0.007	-0.005 (-0.019,0.009)	0.496	0.009 (-0.002,0.021)	0.106
Role conflicts	0.027 (0.009,0.046)	0.004	0.002 (-0.012,0.016)	0.786	0.015 (0.004,0.026)	0.010
Sick leave	0.021 (0.006,0.036)	0.007	-0.003 (-0.017,0.010)	0.656	0.009 (-0.003,0.021)	0.125
Leadership	0.011 (0.000,0.022)	0.045	0.002 (-0.010,0.014)	0.726	0.008 (-0.001,0.017)	0.067
Patient safety climate	0.017 (0.006,0.029)	0.003	0.005 (-0.009,0.020)	0.449	0.003 (-0.013,0.018)	0.717

* The relative 7-day survival (2010-2012) were adjusted for age, gender, number of hospitalizations during the previous two years and a Charlson Comorbidity index score
** All analyses were adjusted for diagnosis and the annual number of treatments on each hospital ward
*** Statistical significance at the P < .05 level.

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Footnotes

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Ethical approval: The Medical and Health Research Ethics Committee (REC) exempted the study from approval since all data used in the study were anonymous.

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Associations between Work Satisfaction, Engagement, and Seven-day Patient Mortality; a Cross-Sectional Survey

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Associations between Work Satisfaction, Engagement, and Seven-day Patient Mortality: A Cross-Sectional Survey

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Abstract

Objective This study examined the association between profession-specific work environment and the seven-day mortality of patients admitted with acute myocardial infarction (AMI), stroke and hip-fracture.

Design A cross-sectional study combining patient mortality data and work environment scores at hospital ward levels.

Setting Fifty-six patient wards in twenty hospitals administered by the South-Eastern Norway Regional Health Authority.

Participants Forty-six thousand and twenty six patients admitted to hospital with AMI, stroke and hip-fracture, and 8,800 survey responses from physicians, nurses, and managers over a three-year period (2010-2012).

Primary and secondary outcome measures The primary outcome measures were the associations between the relative mortality rate for patients admitted with AMI, stroke and hip-fracture and the profession specific (nurses, physicians, middle managers) mean scores on the nineteen organizational factors in the validated cross sectional staff survey conducted in Norway. The secondary outcome measures were mean scores with standard deviation (SD) on the organizational factors in the staff survey reported by each profession.

Results Nurse workload (Beta 0.019 (CI$_{95}$ 0.009-0.028)) and middle manager engagement (Beta 0.024 (CI$_{95}$ 0.010-0.037)) levels were associated with a case-mix adjusted seven-day patient mortality rates. There was no significant association between physician work environment scores and patient mortality rates.

Conclusion Seven-day mortality rates in hospital wards were negatively correlated with the nurse workload and manager engagement levels. A deeper understanding of the relationships between patient outcomes, organizational structure, and their underlying cultural barriers is needed. This will assist in developing and implementing effective and sustainable hospital system interventions that reduce adverse patient outcomes by improving the hospital work environments in which patient care is delivered.

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Strengths and limitations of this study

- To our knowledge, this is the first study combining profession-specific work place survey data with patient mortality data at the hospital ward level.

- This study is strengthened by the use of ward-level data as hospital data can mask inter-ward differences.

- Patient data were case-mix adjusted, but not for the disease severity, thus it is hard to distinguish between patients who might die from the severity of their illness and less severe cases, for whom the lack of high-quality care ultimately reduced their chances of survival.

- Although the study included hospitals providing health care services to more than half of the Norwegian population, the number of wards is not sufficient to allow the use of complex multivariate analysis.

- These data suggest an important role for staff satisfaction and psychological safety, and manager engagement can contribute to producing high-quality outcomes.

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Hospitals are complex social-cultural organizations defined by their complexity of operations, uncertainty and interdependency.[1] A strong linkage between the organization of care and patient outcomes has been found in several studies.[2 3] Complex organizations rely on rich inputs and interactions while they deliver an array of clinical services. In these settings, it can be hard to determine the proximal causes of an adverse patient event such as a cardiac arrest or a medication error.[4 5] Numerous initiatives have been promoted to enhance the quality of the patient's journey when in hospital, and yet at least one in ten patients still experiences adverse events.[6] High-reliability organizational theory posits that organizational features including psychological safety[7], leadership involvement,[8] team based care ,[9] trusting support,[10] and a relentless culture of quality measurement are needed to sustain improvements in care.[11]

The impact of organizational culture on quality, reporting of data, and safety in non-medical organizations is well documented.[12-15] Monitoring staff perceptions of their work environment and their organizational culture is used by managers to discover what is deemed meaningful and makes organizational sense to employees.[16 17] Leggat et al[18] have consistently demonstrated that a reported positive relationship between high-performance workplaces and organizational outcome also applies to patient outcomes in healthcare organizations.[19]

Systems science and human factors engineering posit that focusing on the work environment and elements of organizational culture that support the performance of professionals can reduce work hazards and enable safer outcomes.[20 21] In other words, the organizational culture may be a fundamental determinant of patient outcomes.[22]

Our hypothesis was that there is an association between the work environment and patient mortality, and that this association is profession-specific for nurses, physicians and middle managers. The objective of this study was to examine the associations between profession-specific work environments and the seven-day mortality of patients admitted with one of three diagnoses: acute myocardial infarction (AMI), stroke and hip-fracture.

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METHODS

The survey population was drawn from one healthcare provider, the South Eastern Regional Health Authority (HSO) delivering health care services to more than half of the population in Norway, patient outcome data were derived from a national database (Norwegian Patient Register) for all patients in Norway admitted with AMI, stroke and hip-fracture in 20 hospitals.

Staff in all hospitals administered by the HSO in Norway were invited to participate in a web based work environment survey. More than 75.000 were employed in HSO, and all professionals employed for more than three months in the hospital were eligible for participation. Nearly 50.000 questionnaires were distributed in each of the studied years (2010-2012). The data was collected electronically. To secure anonymity of the participants, only data from wards with more than five responders were processed. The survey instrument used was the validated work environment questionnaire based on the General Nordic Questionnaire for Psychological and Social Factors at Work (QPSnordic), that was adapted for healthcare.[23]

The survey was designed to assess the local hospital work environment and distinguish the differences between hospital wards. The questionnaire has 57 items, measuring the work environment along 19 dimensions. (Table 1) The survey was supplemented with questions addressing the factor patient safety culture as an important aspect of the healthcare work environment. The safety culture questions were adapted from the Norwegian validated version of the Safety Attitude Questionnaire (SAQ)[24] The response alternatives are presented on a 5-point Likert scale (for some items "Strongly disagree", "Disagree", "Neither disagree nor agree", "Agree", "Strongly agree" or, where appropriate, "Never/very seldom", "Seldom", "Sometimes", "Quite often", "Very often/always"). The categories were assigned the values 0-25-50-75-100, assuming equal distance between scores. [25] The value zero reflects the highest burden/least favorable condition and the score 100 means the most positive rating (i.e., is coping/satisfied). The coding of negatively worded items was reversed to ensure that the higher code values always indicate a more positive response. The score on each dimension was calculated as the mean of the score on each item included in the dimension. For each of the 56 wards studied, the mean work environment and patient safety culture scores were calculated. The individual responses

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with missing data were excluded from the analysis. A report with the mean average score on each item and factor in the survey for each ward was produced and made public. Nurses work on one hospital ward and responses were allocated to the specific ward. Physicians and middle managers cover several wards or units. It is the perceptions about the work environments where physicians and middle managers work (entire clinical departments) supporting these patient wards that is measured.

The definitions and measurements of culture vary. For this study, we defined organizational culture as the behaviors that emerge based on shared values, beliefs, assumptions, and norms.[12 13 26] Previous research demonstrated more variation in culture assessments between different clinical wards within the same hospital than between the hospitals.[27] We used the ward level as our level of analyses, as previous studies have shown that data aggregated at hospital level may mask the hospital unit's differences.[28]

Norwegian Knowledge Centre for the Health Services (NOKC) reports hospital survival probabilities for 46.026 patients with AMI, stroke, hip-fracture, and a hospital-wide survival rate quality indicator for Norwegian hospitals.[29] The mortality rates are estimated based on all-cause death, tracking patients with their unique Personal Identification Number. The mortality rate was risk-adjusted for age, gender, and the Charlson Comorbidity index scores based on the patients' hospital admissions three years prior to their admission, type of stroke (cerebral hemorrhage/cerebral infarction) and the total number of hospitalizations during the previous two years. In the event where a patient admission involved more than one hospital, the patient mortality probability was split between the hospitals according to the time the patient spent at each hospital in order to reduce possible bias. The data management and analysis is described by Hassani et al.[30 31] This study used risk adjusted patient data from NOKC for patients admitted to hospitals with AMI, stroke and hip-fracture. The seven-day mortality rate was chosen to study the possible associations between the work environment and mortality for high-risk patients in hospital. A more extended observation period might confound the findings and include mortality unrelated to hospital characteristics, such as variations in post discharge care at local nursing homes and home healthcare services. The ward mortality rate was calculated for the patients with the included diagnosis only, and not, combined with the mortality of patients with other diagnoses, even if they were cared for on the same wards.

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The relative mortality rates were defined as the deviation of the hospital unit's mortality rate from the mean mortality rate for the specific diagnosis group, and then divided by the mean mortality rate for the specific diagnosis group. This relative mortality rate can be compared across all three diagnostic groups and allow pooling of all units. The formula is as follows:

$$Relative\ mortality\ rate_{unit} = \frac{\text{Mean mortality rate}_{patient\ group}\ - Mortality\ rate_{unit}}{\text{Mean mortality rate}_{patient\ group}}$$

The diagnosis-specific outcomes were aggregated over three years (2010-2012) to ensure adequate statistical power.

Selection of Hospitals

All public hospitals administered by HSO providing acute care were included. Twenty hospitals were included, 17 treated all of the three patient diagnosis included in this study, while three only treated one or two of the included patient groups, in total 56 wards. The hospitals varied in size and geographic catchment areas, but had comparable organizational structures, with specially designated wards caring for the three groups of patients. Patients admitted with a cerebral stroke were treated in stroke units according to national guidelines,[32] whereas most patients with a hip-fracture were postoperatively cared for on orthopedic wards. Patients with AMI underwent pre-hospital triage; patients with STEMI infarction are transported directly to PCI centers, whereas, patients with non-STEMI infarction are admitted to cardiac units at each of the respective hospitals.

The ward level data was made available on the work environment scores from HSO and the patient mortality rates were available from the NOKC for a three-year period (2010-2012) and were combined using ward names as an identifier.

Statistical Analyses

Descriptive data on number of patients treated and survey responses were given as median and range due to not being normal distributed. Normality were tested by Kolmogorov–Smirnov test. The associations between the profession-specific work environments and adjusted patient mortality rates at a specific ward level were analyzed

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using a linear regression model that was adjusted for diagnosis and the annual number of treatments. The effects of the different work environmental factors were analyzed and reported separately, as the limited number of wards studied (n=56) prohibited including all explanatory variables in one single multiple predictive model. A backward conditional regression analysis was performed by including all the significant work environmental factors from the initial separate analysis (Nurses: Patient centered, Respect, Motivation, Engagement, Commitment, Role expectations, Workload, Autonomy, Role conflicts, Sick leave, Leadership, Patient safety climate; Physicians: None; Managers: Quality, Motivation, Engagement, Commitment, Personal development, Empowerment, Social climate, Workload, Role conflicts). The level for removal of variables was set to $P>0.05$. The work environment effects for physicians, nurses and middle managers were analyzed separately to assess how patient mortality is associated with the work environment for the three separate professions. The statistical significance level was set at 0.05, and the 95% confidence intervals are presented below. All statistical analyses were carried out using the IBM SPSS statistical package Version 21.

Patient and Public Involvement

The study protocol and the results of this study have been presented for the Regional Patient Representative Committee who supported the study design and its relevance.

RESULTS

The web-based work environment and safety culture data were collected from 2010 to 2012. Nearly 50,000 questionnaires were distributed annually. The response rates for 2010, 2011, and 2012 were 72%, 77%, and 75%, respectively. The background information such as gender, age and profession was stated voluntarily. Seventy-eight percent of the respondents defined their occupation. In total, 5,602 responses from nurses, 2,195 from physicians, and 1,036 from middle managers were included in the analysis. (Table 2)

All emergency patients admitted with AMI, stroke, and hip-fracture were included. Diagnosis-specific mortality rates were calculated for all adult patients (age>18) with the corresponding diagnoses; 17,734 patients admitted with first time acute myocardial

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infarction (AMI) (ICD-10 I21.x), 14,442 cerebral stroke patients (ICD-10 I61.63.64), and

13,850 patients admitted over the age of 65 with a hip-fracture (ICD-10 S72.0-2). The

average length of hospital stay for the patients included in the study was 8.1 days. The

seven-day mortality rate varied from 2.8% - 7.7%. The mean Charlson Comorbidity Index

score was 1.5. (Table 3)

The median number of treatments for the 56 wards that participated in this study,

(patients within the diagnosis codes included) were 214, ranging from 36 to 1242. The

median number of work environment survey responses per ward included in the analysis

was 87 (range 26-296) for nurses, 32 (range 5-157) for physicians, and 15 (range 5-47) for

managers.

Hospital staff rated their work environment, in general, positively on the 0-100 scale

(100 indicating the most favorable condition): the mean scores for nurses, physicians, and

middle managers were 70.5, 67.2 and 76.3, respectively. The middle managers reported

higher scores than physicians and nurses on all but three of the 19 organizational factors,

while the nurses scored lower than managers and physicians on nine of the 19 factors. The

mean scores and standard deviation for each factor by profession are presented in Table 4.

Table 5 shows that several factors were significantly associated with patient mortality

probabilities. The backward regression model demonstrated that a higher perceived

workload by nurses was significantly associated with patient mortality: beta = 0.019 (CI_{95}

0.009, 0.028). Nurses: Workload $P<0.001$, Respect $P=0.002$, Patient safety culture $P=0.003$,

Role conflicts $P=0.004$, Patient centered $P=0.005$, Engagement $P=0.005$, Autonomy $P=0.007$,

Sick leave $P=0.007$, Commitment $P=0.009$, Motivation $P=0.022$, Role expectation $P=0.031$,

Leadership $P=0.045$. For middle managers, engagement was significantly associated with

seven-day mortality: beta= 0.024 (CI_{95} 0.010, 0.037). Middle managers: Engagement

$P=0.001$, Personal development $P=0.001$, Motivation $P=0.002$, Social climate $P=0.005$,

Workload $P=0.006$, Commitment $P=0.010$, Role conflict $P=0.010$. No significant association

was found between the physician reported work environment scores and patient mortality.

DISCUSSION

The major findings of this study are the correlations between organizational work

environment and seven-day patient mortality. This study extends findings in the literature

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demonstrating that the work environment at the 20 hospitals in the South Eastern Norway Health Region were significantly related to their reported seven-day mortality for patients admitted with AMI, stroke and hip-fractures. We observed a significant increase in patient mortality in hospital units where nurses reported excessive workload and middle managers reported a lack of professional and organizational engagement. No such associations were found between physician reported work environment and patient mortality.

Hospital staff scored their work environment positive (over 70) on a 0-100 scale (100 indicating the most favorable situation), consistent with the general satisfaction reported by Norwegian employees who report higher job satisfaction than employees in other countries.[33] However, there were profession-specific differences that may have contributed to the observed variation in the patient outcomes across the 56 hospital wards. Overall, the middle managers scored higher than physicians and nurses, and nurses scored lowest on more organizational factors than managers and physicians.

Whereas nurses typically worked on one hospital ward, physicians and middle managers usually worked across several clinical units, and the assessment of their work environment should be interpreted accordingly. We stress that it is not the physician or manager perceptions of the patient ward that are being measured, but the explicit perceptions about the work environments where physicians and middle managers work (entire clinical departments) supporting these patient wards.

Twelve of the 19 organizational environmental and workload factors scored by nurses were significantly associated with seven-day patient mortality suggesting that the nursing workload associated may be underappreciated.[34] The workload was the most prominent and derived from survey items such as *"Is the physical load of your work too heavy?", "Is your workload challenging?",* and *"Do you perform work tasks for which you need more training?".* These survey items describe the nurse's perceptions of their degree of control over the daily tasks assigned to them. Our findings reinforce results from previous studies suggesting that reducing the nurse workload may decrease patient mortality. [35-41]

As frontline leaders, managers play a critical role in building and nurturing a psychologically safe culture by setting the norms of speaking up, and promoting shared *meanings* and *practices*. [42 43] The middle managerial roles, situated between the senior hospital management and front-line workers, offers a unique vantage point to implement and oversee strategies and work policies. At the same time, middle managers are

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responsible for bringing staff concerns and needs back to senior management for consideration and action. Managers can contribute to organizational change by capitalizing on this position, [44] as management involvement and engagement have been documented as a positive influence on care delivery systems. [8 45 46] At the same time, engagement of top-management and hospital boards in patient safety initiatives can enhance the middle managers' support for a safety culture that can, among other things, affect patient mortality.[47]

As noted above, we did not find a correlation between patient mortality and physicians' perception of their work environment. The interpretation does not necessarily mean that physician work environment is unrelated to patient outcomes. We think this is the result of physicians' sense of autonomy [48] and their responsibility covering patients on multiple departments and service lines simultaneously and this might affect their responses. For nurses the definition of their work environment is more straightforward. Their work is generally restricted to one ward, and they will have this ward in mind when responding to work surveys. Nurses report to, and are assigned tasks by, a supervisor on a daily basis; the same cannot be said for physicians who have much more autonomy about when and where their care activities takes place. This structural difference can lead to a physician-as-manager philosophy and a nurse-as-employee philosophy in many healthcare organizations and contribute to variation seen when assessing impact of clinical interventions in different providers. Previous research has identified differences in culture and work styles within hospitals, and much of this variance was found to be located at the ward and microsystem levels.[49] The responses from physicians working on several wards may attenuate these inter-ward differences: their answers are based on their "average experiences" from several clinical environments. This might explain the physician lack of significant association by hospital ward.

We focused on mortality rates as our dependent variable as mortality is well-defined, easily measured, considered useful for estimating the effect of hospital care, [31 50] and "it matters a lot to patients".[51] Patient mortality rates in Norwegian hospitals and the variation between hospitals is lower than in other OECD countries.[52] However, some Norwegian hospitals have mortality rates significantly higher than the national average. Although a significant part of the variation seen in the observed hospital mortality can be explained by differences in the case mix and random variation, it has been suggested that as much as 30-

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60% of this variation can be attributed to differences in the quality of patient care.[53] Some hospitals have structures and processes that minimize avoidable patient deaths better than others.[54] Studying these high performing hospitals can be valuable as they provide wisdom about factors most important for organizational success and reliability.[55]

Our results must be viewed within the context of the study design. First, the lack of detailed data available on the severity of the patient's illness at the time of their hospital admission. Our data was case-mix adjusted for age, gender, comorbidity, and the number of previous hospitalizations two years before the present admission, but not for the disease severity of each diagnosis. Accordingly, it is challenging to distinguish between patients who may have died from the severity of their illness and less severe cases, for whom the lack of high-quality care ultimately reduced their chances of survival.

Second, the study design did not allow linking of nurse, physician and middle manager' care culture evaluation to the survival of the individual patients under their care. That is, we were only able to relate the average staff evaluations to the average patient mortality for each unit. However, we addressed this by using a diagnosis-specific mortality rate that allowed us to link the work environmental perceptions to the hospital wards where the patients were most likely treated for their primary diagnosis. This afforded us the opportunity to dig deeper into our study dataset to examine the robust links between the work environment and patient outcomes. Aggregated hospital data can mask the unit variation within each hospital.

Third, the previous safety culture literature may also be subject to publication bias.[56] Few randomized controlled studies exist to demonstrate causal relationships between safety culture and clinical outcomes. Thus, our findings are important and have practical implications. Also, the culture evaluation surveys are susceptible to response bias at both the individual and ward respondent levels, but our response rate of 70-75% compares favorably with those of similar studies.[57] We believe that one should consider other methodologies (qualitative/ethnographic) as useful tools for exploring the informal work cultures of the high and low performing wards in our study.[58]

Because all the analyses are conducted at the ward level, our sample of 56 wards is relatively small to detect statistical significance, making the size and direction of the correlation coefficients more informative in this context. Although the included hospitals studied represent nearly half of all Norwegian hospital beds, Norway is a small country and

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the limited number of units prevent complex multivariate analyses. This could mean that the variables that could have explained the mortality variation could not be controlled for. We therefore cannot rule out the possibility that the associations we observed may be non-causal correlations.

Finally, our study reflects the context and distinct constraints of the Norwegian healthcare delivery systems, which may be different from other healthcare systems. Norwegian employees generally perceive their work environment as more positive than staff in other countries,[33] and patient survival is relatively high,[52] but, the study probably carries relevance for the population as a whole, and to other countries, because it stems from a large and diverse sample of hospitals.

CONCLUSIONS

Patients seem to fare better in hospitals that are described by employees as better places to work. Our findings suggest a significant correlation between organizational features of care delivery systems and patient hospital mortality. A deeper understanding of these influences is critical to developing meaningful interventions to improve patient outcomes and should be used in monitoring the work environment.

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Table 1. Work Environmental Factors and Culture Survey Items

Domain scales	Items
Goals	The unit goals are well known to all employees I know how I can contribute to the unit to reach its goals We regularly evaluate our achievements according to our goals
Improvement	In my unit, we do well in reporting and follow up on adverse events It is safe to report adverse events in my/this unit We openly discuss adverse events and learn from them In this unit, we encourage each other to think of ways to do things better
Quality	In my unit different professions collaborate well We work efficiently in my unit In my unit high quality is maintained
Patient-centered	In my unit, we listen to the views of patients/clients In my unit, we are available to patients/clients In my unit, sufficient information is given to patients/clients
Respect	In my unit, we respect patients/clients cultural background and religion In my unit, we comply to keep appointments made In my unit, we communicate clearly and in an understandable way
Motivation	Is your work challenging in a positive way My work tasks engage me The work is so interesting in itself that it is strongly motivating
Engagement	Do you look forward going to work How often does dissatisfaction with your work make you want to change employer Overall, how satisfied are you with the work you do now
Commitment	To my friends, I praise this organization as a great place to work This organization inspires me to give my very best job performance I am proud of my workplace
Personal development	I can develop professionally through my work I get sufficient training and advice to do a good job Is your work organized in a way that lets you improve your abilities Do you get feedback about the quality of the work you do
Empowerment	Are you encouraged to participate in decision making Are you encouraged to speak up when you have a different opinion
Role expectations	Do you know what your responsibilities are Do you know what is expected of you at work
Social climate	Is the social climate in your unit characterized by a team spirit If needed, can you get support and help from your coworkers Do you perceive good collaboration in your unit
Conflicts and bullying	Have you observed anyone being harassed or bullied at your workplace during the last six months

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	Have you noticed disruptive conflicts in your unit
	When conflicts occur, are they handled in a professional manner
Workload	Is the physical load of your work too burdensome
	Is your work pace challenging
	Is your workload challenging
	Do you perform work tasks for which you need more training
Autonomy	Can you influence the amount of work assigned to you
	Can you set your own work pace
Role conflicts	Do you have to perform procedures which you feel should be done differently
	Are you given assignments without adequate resources to complete them
	Do you receive incompatible requests
Sick leave	Issues at work have contributed to my sick leaves during the last 12 months
Leadership	My immediate superior is available to me when I need it
	My immediate superior does an excellent job of giving us information about what goes on in our organization
	My immediate superior makes clear performance demands
	My immediate superior adheres to what we have agreed upon
	If I were subjected to violence or threats, I could count on the support of my immediate superior
	If I were sick for a more extended period, I could count on the support of my immediate superior
Patient safety culture	I would feel safe if I was a patient here
	Adverse medical events are appropriately handled here

Table 2. Description of Survey Respondents by Age and Profession

	N	Age					Permanent employment	Female
		<30	30-39	40-49	50-59	60+		
Physician	2195	5.5%	40.7%	25.7%	17.9%	10.3%	68.9%	44.3%
Nurses	5602	15.3%	27.4%	26.2%	25.0%	6.1%	92.2%	90.9%
Managers	1036	0.7%	13.0%	33.7%	41.0%	11.6%	96.9%	68.1%

Table 3. Description of Patients and Clinical Outcomes

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	Acute Myocardial infarction (first time)	Stroke	Hip fracture >65 years
Number of patients	17734	14442	13850
Number of admissions	17734	15235	14427
Death within 7 days, unadjusted	1234 (7.0%)	1180 (7.7%)	399 (2.8%)
Death within 30 days, unadjusted	2030 (11.4%)	2167 (14.2%)	1314 (9.1%)
Mean length of stay (days)	7.0	10.2	7.2
Treated in two or more hospitals	10412 (58.7%)	1915 (12.6%)	1252 (8.7%)
Gender, female	6785 (38.3%)	7297 (47.9%)	10297 (71.4%)
Age, mean	71.0	74.6	83.4
0-17 years	0 (0.0%)	0 (0.0%)	0 (0.0%)
18-49 years	1411 (8.0%)	777 (5.1%)	0 (0.0%)
50-75 years	8854 (49.9%)	6234 (40.9%)	2549 (17.7%)
>75 years	7469 (42.1%)	8224 (54.0%)	11878 (82.3%)
Number of previous hospitalization during last two years, mean	5.8	5.8	5.9
0	3786 (21.3%)	2432 (16.0%)	1652 (11.5%)
1	2799 (15.8%)	2181 (14.3%)	2069 (14.3%)
2	2189 (12.3%)	1914 (12.6%)	2008 (13.9%)
3-5	4130 (23.3%)	3922 (25.7%)	4142 (28.7%)
6+	4830 (27.2%)	4786 (31.4%)	4556 (31.6%)
Charlson comorbidity index, mean	1.5	1.3	1.8
0 points	8827 (49.8%)	8131 (53.4%)	5914 (41.0%)
1 points	1646 (9.3%)	1658 (10.9%)	1404 (9.7%)
2 points	3096 (17.5%)	2638 (17.3%)	3493 (24.2%)
3+ points	4165 (23.5%)	2808 (18.4%)	3616 (25.1%)

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11   Table 4. Hospital Units Organizational Factor Score Averages by Professions (N=56)
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Measures	Nurse Mean	SD	Physician Mean	SD	Managers Mean	SD
Goals	62	7	63	9	72	8
Improvement	65	6	69	7	76	6
Quality and efficiency	77	6	77	8	78	8
Patient-centered	76	6	76	6	77	6
Respect for patients	74	4	74	6	76	6
Motivation	75	5	78	7	82	5
Engagement	76	7	75	8	81	7
Commitment	75	9	71	10	81	7
Personal development	62	7	63	8	70	9
Empowerment	55	6	60	9	74	9
Role expectations	89	3	85	6	88	5
Social interactions	83	6	79	8	81	7
Conflicts and bullying	75	5	73	9	81	7
Workload	52	9	54	7	62	7
Autonomy	39	7	38	7	46	9
Role conflicts	68	5	66	7	64	9
Sick leave	86	6	93	8	94	8
Leadership	74	9	75	9	77	12
Patient safety culture	78	8	85	7	90	7

Table 5. Association between each Organizational Factors and relative seven-day mortality

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Relative 7-day mortality (2010-2012) Diagnosis-specific*	Nurse		Physician		Managers	
	Beta (95% CI)	p-value	Beta (95% CI)	p-value	Beta (95% CI)	p-value
Goals	0.008 (-0.006,0.022)	0.245	0.007 (-0.003,0.019)	0.204	0.009 (-0.003,0.021)	0.139
Improvement	0.011 (-0.005,0.027)	0.189	0.008 (-0.007,0.023)	0.305	0.012 (-0.004,0.027)	0.130
Quality	0.017 (-0.001,0.034)	0.057	0.004 (-0.008,0.016)	0.481	0.014 (0.001,0.027)	0.032
Patient centered	0.023 (0.007,0.039)	0.005	0.001 (-0.015,0.017)	0.882	0.014 (-0.001,0.030)	0.075
Respect	0.035 (0.013,0.057)	0.002	0.005 (-0.013,0.023)	0.577	0.015 (-0.002,0.031)	0.077
Motivation	0.024 (0.004,0.044)	0.022	-0.004 (-0.019,0.010)	0.53	0.028 (0.010,0.045)	0.002
Engagement	0.021 (0.007,0.036)	0.005	-0.006 (-0.019,0.008)	0.407	0.024 (0.010,0.037)	0.001
Commitment	0.015 (0.004,0.026)	0.009	-0.004 (-0.017,0.009)	0.537	0.018 (0.004,0.031)	0.010
Personal development	0.012 (-0.002,0.025)	0.094	-0.002 (-0.017,0.014)	0.826	0.018 (0.007,0.029)	0.001

Empowerment	0.010 (-0.006,0.025)	0.231	0.000 (-0.012,0.011)	0.948	0.011 (0.001,0.022)	0.037
Role expectations	0.039 (0.004,0.074)	0.031	0.003 (-0.014,0.019)	0.750	0.011 (-0.008,0.031)	0.236
Social climate	0.012 (-0.006,0.030)	0.194	-0.008 (-0.020,0.004)	0.211	0.019 (0.006,0.031)	0.005
Conflicts and bullying	0.003 (-0.017,0.023)	0.765	-0.009 (-0.021,0.002)	0.111	0.010 (-0.005,0.026)	0.180
Work load	0.019 (0.009,0.028)	<0.001	-0.002 (-0.016,0.012)	0.742	0.018 (0.005,0.031)	0.006
Autonomy	0.021 (0.006,0.035)	0.007	-0.005 (-0.019,0.009)	0.496	0.009 (-0.002,0.021)	0.106
Role conflicts	0.027 (0.009,0.046)	0.004	0.002 (-0.012,0.016)	0.786	0.015 (0.004,0.026)	0.010
Sick leave	0.021 (0.006,0.036)	0.007	-0.003 (-0.017,0.010)	0.656	0.009 (-0.003,0.021)	0.125
Leadership	0.011 (0.000,0.022)	0.045	0.002 (-0.010,0.014)	0.726	0.008 (-0.001,0.017)	0.067
Patient safety climate	0.017 (0.006,0.029)	0.003	0.005 (-0.009,0.020)	0.449	0.003 (-0.013,0.018)	0.717

* The relative 7-day survival (2010-2012) were adjusted for age, gender, number of hospitalizations during the previous two years and a Charlson Comorbidity index score
** All analyses were adjusted for diagnosis and the annual number of treatments on each hospital ward
*** Statistical significance at the $P< 0.05$ level.

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Footnotes

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STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No.	Recommendation	Page No.	Relevant text from manuscript
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1	Associations between Work Satisfaction, Engagement, and Seven-day Patient Mortality: a Cross-Sectional Survey.
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2	
Introduction				
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4	
Objectives	3	State specific objectives, including any prespecified hypotheses	4	Our hypothesis was that there is an association between work environment and mortality, and that this association is profession-specific for nurses, physicians and middle managers.
Methods				
Study design	4	Present key elements of study design early in the paper	5	
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5,6,7	
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	5,6,7	All the health professionals who were employed for more than three months in the hospital were eligible for participation. * All adult patients admitted to hospital with AMI, stroke (>18

					years) and hip-fracture (>65 years).
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed			
		Case-control study—For matched studies, give matching criteria and the number of controls per case	NA	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5,6,7	
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7	The patient hospital ward level data were made available on work environment scores from the HSO, and the patient mortality rates were from the NOKC for a three-year period (2010-2012) were combined using the hospital ward names as an identifier.
Bias	9	Describe any efforts to address potential sources of bias	6,7	The mortality rate was risk adjusted for age, gender, and the Charlson Comorbidity index scores based on the patients' admissions to hospitals, three years prior to admission, type of stroke (cerebral hemorrhage /cerebral infarct) and by the total number of hospitalizations

				during the previous two years. Diagnosis-specific outcomes were aggregated over the three years (2010-2012) to ensure there was adequate statistical power.
Study size	10	Explain how the study size was arrived at	5,7	All adult patients with the indicated diagnoses were included. All staff responding to the survey and stating their profession as nurse, physician or middle manager were included.

Continued on next page

Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7	$Relative\ mortality\ rate_{unit} = \dfrac{Mean\ mortality\ rate_{patient\ group}}{Mean\ mortality\ r}$	
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8		
		(*b*) Describe any methods used to examine subgroups and interactions	NA		
		(*c*) Explain how missing data were addressed	NA		
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	NA		
		(*e*) Describe any sensitivity analyses	NA		
Results					
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	5,6		
		(b) Give reasons for non-participation at each stage	NA	All are included.	
		(c) Consider use of a flow diagram			
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	15,16	See Tables 2 and 3	
		(b) Indicate number of participants with missing data for each variable of interest	8	Only 78% of participants stated their profession. Due to anonymity, we have no information about who did not provide this information.	
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)			
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time			
		Case-control study—Report numbers in each exposure category, or summary measures of exposure			
		Cross-sectional study—Report numbers of outcome events or summary measures	17,18	See Tables 4 and 5	

Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	18	See Table 5 Adjusted for diagnosis and the annual number of treatment on each ward.
		(*b*) Report category boundaries when continuous variables were categorized	NA	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA	

Continued on next page

Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA

Discussion

Key results	18	Summarise key results with reference to study objectives	10	The major findings of this study are the strong associations between the organizational work environment and seven-day patient mortality.
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	12	
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13	
Generalisability	21	Discuss the generalisability (external validity) of the study results	13	

Other information

Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	NA

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Associations between Work Satisfaction, Engagement, and 7-day Patient Mortality; a Cross-Sectional Survey

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Associations between Work Satisfaction, Engagement, and 7-day Patient Mortality: A Cross-Sectional Survey

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Keywords: Patient safety, work environment, patient outcome, safety culture, safety climate, staff engagement

Word Count: 3594

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Abstract

Objective: This study examines the association between profession-specific work environments and the 7-day mortality of patients admitted to these units with acute myocardial infarction (AMI), stroke and hip-fracture.

Design: A cross-sectional study combining patient mortality data extracted from the South-Eastern Norway Health Region, and the work environment scores at the hospital ward levels. A case-mix adjustment model was developed for the comparison between hospital wards.

Setting: Fifty-six patient wards in twenty hospitals administered by the South-Eastern Norway Regional Health Authority.

Participants: In total, 46,026 patients admitted to hospitals with AMI, stroke and hip-fracture, and supported by 8,800 survey responses from physicians, nurses, and managers over a three-year period (2010-2012).

Primary and secondary outcome measures: The primary outcome measures were the associations between the relative mortality rate for patients admitted with AMI, stroke and hip-fractures and the profession-specific (i.e., nurses, physicians, middle managers) mean scores on the nineteen organizational factors in a validated cross sectional, staff survey conducted annually in Norway. The secondary outcome measures were the mean scores with standard deviations (SD) on the organizational factors in the staff survey reported by each profession.

Results: The Nurse workload (Beta 0.019 (CI_{95} 0.009-0.028)) and middle manager engagement (Beta 0.024 (CI_{95} 0.010-0.037)) levels were associated with a case-mix adjusted seven-day patient mortality rates. There was no significant association between physician work environment scores and patient mortality rates.

Conclusion: 7-day mortality rates in hospital wards were negatively correlated with the nurse workload and manager engagement levels. A deeper understanding of the relationships between patient outcomes, organizational structure, and their underlying cultural barriers is needed because they may provide a better understanding of the harm

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and death risks for patients due to organizational characteristics.

Strengths and limitations of this study

- This is the first study, to our knowledge, combining profession-specific work place survey data with patient mortality data correlated with the hospital ward levels.

- This study is strengthened by the use of ward specific level data as hospital data can mask inter-ward differences.

- A case-mix adjustment model was developed for the comparison between hospital wards but not for the disease severity, thus it is hard to distinguish between patients who might die from the severity of their illness and less severe cases, for whom the lack of high-quality care ultimately may have reduced their chances of survival.

- Although the study included hospitals providing health care services to more than half of the Norwegian population, the number of wards is too small to allow the use of complex multi-variate analyses.

- These data suggest a unique and important role for staff satisfaction and psychological safety.

3

Hospitals are complex social-cultural organizations defined by their complexity of operations, uncertainty and interdependency.[1] A strong linkage between the organization of care and patient outcomes has been found in several studies.[2][3] Complex organizations rely on authentic inputs and interactions while they deliver an array of clinical services. In these settings, it can be hard to determine the proximal causes of an adverse patient event such as a cardiac arrest or a medication error.[4][5] Numerous initiatives have been promoted to enhance the quality of the patient's journey when in hospital, and yet at least one in ten patients still experiences adverse events.[6] High-reliability organizational theory posits that organizational features including psychological safety[7], leadership involvement,[8] team based care ,[9] trusting support,[10] and a relentless culture of quality measurement are needed to sustain reliable improvements in care.[11]

The impact of organizational culture on quality, reporting of data, and safety in non-medical organizations is well documented.[12-15] Monitoring staff perceptions of their work environment and their organizational culture is used by managers to discover what is deemed meaningful and makes organizational sense to employees.[16][17] Leggat et al[18] have consistently demonstrated that a reported positive relationship between high-performance workplaces and organizational outcome also applies to patient outcomes in healthcare organizations.[19]

 Systems science and human factors engineering posit that focusing on the workflow and environment, and the organizational culture can reduce work hazards and enable safer outcomes.[20][21]

Our hypothesis was that there is an association between the work environment and patient mortality, and that this association is profession-specific for nurses, physicians and middle managers. The secondary objective of this study was to examine the associations between profession-specific work environments and the seven-day mortality of patients admitted with one of three diagnoses: acute myocardial infarction (AMI), stroke and hip-fracture.

METHODS

The survey population was drawn from one healthcare service provider, the South-Eastern Regional Health Authority (HSO), which is responsible for delivering health care services to approximately 3 million people - more than half of the population in Norway. The patient outcome data were derived from a national database (Norwegian Patient Register)

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for all patients admitted with AMI, stroke and hip-fracture in 20 hospitals in Norway.

Staff in all hospitals administered by the HSO in Norway were invited to participate in a web-based work environment questionnaire based on the General Nordic Questionnaire for Psychological and Social Factors at Work (QPSnordic), that was adapted for healthcare.[22] More than 75,000 are employed in HSO, and all staff employed for more than three months in the hospital were eligible for participation. Nearly 50,000 questionnaires were distributed in each of the studied years (2010, 2011, 2012). The data was collected electronically. To secure anonymity of the participants, only data from wards with more than five responders were processed.

The survey was designed to assess the local hospital work environment and distinguish the differences between hospital wards. The questionnaire has 57 items, measuring the work environment along 19 dimensions. (Table 1) The survey was supplemented with questions addressing the factor patient safety culture as an important aspect of the healthcare work environment. The safety culture questions were adapted from the Norwegian validated version of the Safety Attitude Questionnaire (SAQ).[23] The response alternatives are presented on a 5-point Likert scale (for some items "Strongly disagree", "Disagree", "Neither disagree nor agree", "Agree", "Strongly agree" or, where appropriate, "Never/very seldom", "Seldom", "Sometimes", "Quite often", "Very often/always"). The categories were assigned the values 0-25-50-75-100, assuming an equal distance between scores. [24] The value zero reflects the highest burden/least favorable conditions and the score 100 means the most positive rating (i.e., is coping/satisfied). The coding of negatively worded items was reversed to ensure that the higher code values always indicate a more positive response. The score on each dimension was calculated as the mean of the score on each item included in the dimension. For each of the 56 wards in the study, the mean work environment scores were calculated. The individual responses with missing data were excluded from the analysis. A report with the mean average scores on each item and factor in the survey for each ward was produced and made public. Nurses in HSO are assigned to work on one designated hospital ward and the nurse responses were attributed to the specific ward, however, physicians and middle managers cover several wards or units. We measured the perceptions about the work environments where the physicians and middle managers work (entire clinical departments).

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We defined the work system to include the persons, organization, tools and technologies, tasks and their work environment.[25] Work environment is the *physical and organizational culture under which healthcare professionals perform their tasks*. Patient safety culture is a component of organizational culture and has been shown to be associated with patient outcomes.[26]

The definitions and measurements of culture vary. For this study, we defined organizational culture as *the behaviors that emerge based on shared values, beliefs, assumptions, and norms*.[12 13 27] Previous research has demonstrated more variation in culture assessments between different clinical wards within the same hospital than between the hospitals.[28] We used the ward level as our level of outcomes , as previous studies have shown that data aggregated at the hospital level may mask the hospital unit's differences.[29]

The Norwegian Institute of Public Health (FHI) reports annually hospital survival probabilities for patients diagnosed with AMI, stroke, hip-fracture, and hospital-wide survival rate quality indicators for Norwegian hospitals.[30] The mortality rates are estimated based on all-cause deaths, tracking patients with their unique Norwegian Personal Identification Number. The mortality rates were risk-adjusted for age, gender, and the Charlson Comorbidity index scores based on the patients' hospital admissions during the three years prior to their hospital admission, type of stroke (cerebral hemorrhage/cerebral infarction), and the total number of hospitalizations during the previous two years. In the event where a patient admission involved more than one hospital, the patient mortality probability was split between the two hospitals according to the time the patient spent at each hospital in order to reduce potential bias. The management and analysis methods of the Norwegian survival data are described in great detail by Hassani et al.[31 32] This study used risk-adjusted patient data from the FHI for patients admitted to hospitals with AMI, stroke and hip-fracture.

The 7-day mortality rate was chosen to study the possible associations between the work environment and mortality for high-risk patients in hospital. A more extended observation period (such as 30-day), might confound the findings and include mortality unrelated to hospital characteristics, such as variations in post discharge care at local nursing homes and home healthcare services. Importantly, the ward mortality rates were calculated for the patients with the included diagnosis only, and not combined with the mortality of

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patients with other diagnoses, even if they were cared for on the same wards.

The relative mortality rates were defined as the deviation of the hospital unit's mortality rates from the mean mortality rates for the specific diagnosis groups, and then they were divided by the mean mortality rates for the specific diagnosis group. This relative mortality rate can be compared across all three diagnostic groups and allows for pooling of all hospital ward data. The formula we used is as follows:

$$Relative\ mortality\ rate_{unit} = \frac{\text{Mean mortality rate}_{patient\ group} - Mortality\ rate_{unit}}{\text{Mean mortality rate}_{patient\ group}}$$

The diagnosis-specific outcomes were aggregated over a three-year period (2010, 2011, 2012) to ensure adequate statistical power.

Selection of Hospitals

All twenty public hospitals in HSO providing acute care were included, with 17 hospitals that treated all three patient diagnoses included in this study, while three hospitals treated only one or two of the three included patient sub-groups, for a total of 56 wards. The hospitals varied in size and geographic catchment areas, but had comparable organizational structures and policies, with specially designated patient wards caring for the three subgroups of patients. Patients admitted with a cerebral stroke were treated in stroke units according to national guidelines,[33] whereas patients with a hip-fracture were postoperatively cared for on orthopedic wards. Patients with AMI were subjected to a pre-hospital triage such that patients with suspected STEMI infarction were transported directly to PCI centers, whereas, patients with non-STEMI infarction were admitted to cardiac units at each of the respective HSO hospitals.

The ward level data on the work environment scores was made available from HSO and the patient mortality rates were made available from the FHI for the three-year period (2010, 2011, 2012) and were combined using ward names as an identifier.

Statistical Analyses

The descriptive data on number of patients treated and survey responses were given as medians and the range due to the non-normal distribution. Normality was tested by the

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nonparametric Kolmogorov–Smirnov test.[34] The associations between the profession-specific work environments and adjusted patient mortality rates at a specific ward level were analyzed using a linear regression model that was adjusted for diagnosis and the annual number of treatments.

The effects of the different work environmental factors were analyzed and reported separately, as the limited number of wards studied (n=56) prohibited including all explanatory variables in one single multi-variable predictive model. A backward conditional regression analysis was performed by including all the significant work environmental factors from the initial separate analysis (Nurses: Patient centered, Respect, Motivation, Engagement, Commitment, Role expectations, Workload, Autonomy, Role conflicts, Sick leave, Leadership, Patient safety climate; Physicians: None; Managers: Quality, Motivation, Engagement, Commitment, Personal development, Empowerment, Social climate, Workload, Role conflicts). The level for the removal of variables was set to $P>0.05$. Both the variables available for the backward regression and the final models were evaluated against our hypothesis and prior research and was found to be plausible. In addition alternative approaches as manually built models did not identify better performing models. The work environment effects for physicians, nurses and middle managers were analyzed separately to assess how patient mortality was associated with the work environment for the three professions. The statistical significance level was set at 0.05, and the 95% confidence intervals are presented below. All outcomes and statistical analyses were carried out using the IBM SPSS statistical package Version 21.

Patient and Public Involvement

The study protocol and results of this study have been presented to the Regional Patient Representative Committee who supported the study design and its relevance.

RESULTS

Safety Culture Survey

The web-based work environment and safety culture data were collected from 2010 to 2012. Nearly 50,000 questionnaires were distributed annually. The response rates for 2010, 2011, and 2012, were 72%, 77%, and 75%, respectively. The background information

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such as gender, age and profession was stated voluntarily. Seventy-eight percent of the respondents defined their occupation. In total, 5,602 responses from nurses, 2,195 from physicians, and 1,036 from middle managers were included in the analysis. (Table 2)

All emergency patients admitted with AMI, stroke, and hip-fracture were included. Diagnosis-specific mortality rates were calculated for all adult patients (age>18) with the corresponding diagnoses as follows: 17,734 patients admitted with first time acute myocardial infarction (AMI) (ICD-10 I21.x), 14,442 cerebral stroke patients (ICD-10 I61.63.64), and 13,850 patients admitted over the age of 65 with a hip-fracture (ICD-10 S72.0-2). The average length of hospital stay for the patients included in the study was 8.1 days. The 7-day mortality rates varied from 2.8% - 7.7%. The mean Charlson Comorbidity Index score was 1.5. (Table 3)

The median number of treatments for the 56 wards that participated in this study, (patients within the diagnosis codes included) were 214, with a range varying from 36 to 1242. The median number of work environment survey responses per ward included in the analysis was 87 (range 26-296) for nurses, 32 (range 5-157) for physicians, and 15 (range 5-47) for managers.

Hospital staff rated their work environment positively on the 0-100 scale (100 indicating the most favorable condition): the mean scores for nurses, physicians, and middle managers were 70.5, 67.2 and 76.3, respectively. The middle managers reported higher scores than physicians and nurses on all but three of the 19 organizational factors, while the nurses scored lower than managers and physicians on nine of the 19 factors. The mean scores and standard deviation for each factor are presented by profession in Table 4.

Table 5 shows that several organizational factors were significantly associated with increased patient mortality probability. The backward regression model demonstrated that a higher perceived workload by nurses was significantly associated with increased patient mortality: beta = 0.019 (CI_{95} 0.009, 0.028). <u>Nurses</u>: Workload $P<0.001$, Respect $P=0.002$, Patient safety culture $P=0.003$, Role conflicts $P=0.004$, Patient centered $P=0.005$, Engagement $P=0.005$, Autonomy $P=0.007$, Sick leave $P=0.007$, Commitment $P=0.009$, Motivation $P=0.022$, Role expectation $P=0.031$, Leadership $P=0.045$. For middle managers, engagement was significantly associated with seven-day mortality: beta= 0.024 (CI_{95} 0.010,

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0.037). <u>Middle managers</u>: Engagement *P*=0.001, Personal development *P*=0.001, Motivation *P*=0.002, Social climate *P*=0.005, Workload *P*=0.006, Commitment *P*=0.010, Role conflict *P*=0.010. No significant association was found between the physician reported work environment scores and patient mortality.

DISCUSSION

We found a strong correlation between organizational work environment and 7-day patient mortality. This study extends findings in the literature demonstrating that the work environment at the 20 South-Eastern Norway Health Region Hospitals were significantly related to their reported 7-day mortality for patients admitted with AMI, stroke and hip-fractures. We observed a significant increase in patient mortality in hospital units where nurses reported excessive workload and middle managers reported a lack of professional and organizational engagement. No such associations were found between physician reported work environment and patient mortality.

Hospital staff scored their work environment positive (over 70) on a 0-100 scale (100 being the most favorable), consistent with the general satisfaction reported by Norwegian employees who report higher job satisfaction than employees in other countries.[35] However, there were profession-specific differences that may have contributed to the observed variation in the patient outcomes across the 56 hospital wards. Overall, the middle managers scored higher than physicians and nurses, and nurses scored lowest on more organizational factors than managers and physicians.

Whereas nurses typically worked on one hospital ward, physicians and middle managers usually worked and saw patients on several clinical units, and the assessment of their work environment should be interpreted accordingly. We stress that it is not the physician or manager perceptions of the patient ward that are being measured, but the explicit perceptions about their work environments where physicians and middle managers work (entire clinical departments) supporting these patient wards.

Twelve of the 19 organizational environmental factors scored by nurses were significantly associated with 7-day patient mortality suggesting that the reported nursing workload may be underappreciated as an important driver for nurse satisfaction.[36] The workload was the most prominent and derived from survey items such as *"Is the physical load of your work too heavy?"*, *"Is your workload challenging?",* and *"Do you perform work*

tasks for which you need more training?" These survey items describe the nurses'

perceptions about their degree of control over the daily assigned tasks. Our findings

reinforce previous studies suggesting that reducing the nurse workload may increase nurse

satisfaction and decrease patient mortality. [37-43]

Managers play a critical role, as frontline leaders, in nurturing a psychologically safe

culture by setting the norms for speaking up, and promoting shared *meanings* and *practices*.

[44-46] The middle managerial roles, situated between the senior hospital management and

front-line workers, offers a unique vantage point to assess the maturity of the culture as

they implement and oversee strategies and work policies. At the same time, middle

managers are responsible for bringing staff concerns and needs back to senior management

for consideration and action. Managers can contribute to organizational change by

capitalizing on this position, [47] as management involvement and engagement have been

documented as a positive influence on care delivery systems. [8 48 49] At the same time, top-

management and hospital boards engagement in patient safety initiatives can enhance the

middle managers' support for a safety culture that can affect patient mortality.[50]

As noted above, we did not find a correlation between patient mortality and

physicians' perception of their work environment. The interpretation may not necessarily

mean that physician work environment is unrelated to patient outcomes. We think this may

be the result of physicians' sense of autonomy [51] and their responsibility covering patients

on multiple departments and service lines simultaneously and this might affect their

responses. Nurses define their work environment in more straightforward terms. Their work

is generally restricted to one patient ward, and they will have this ward in mind when

responding to work surveys. Nurses report to, and are assigned tasks by, a supervisor on a

daily basis; the same cannot be said for physicians who have much autonomy about when

and where their care activities take place. This structural difference can lead to a physician-

as-manager philosophy and a nurse-as-employee philosophy in many healthcare

organizations and contribute to variation seen when assessing the impact of clinical

interventions on different providers. Previous research has identified differences in culture

and work styles within hospitals, and much of this variance was found to be located at the

ward and microsystem levels.[29] The responses from physicians working on several hospital

wards may attenuate these inter-ward differences, as their answers are based on their

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"average experiences" from several clinical environments. This might explain the physician lack of significant association by hospital ward.

We focused on mortality rates as our dependent variable as mortality is well-defined, easily measured, considered useful for estimating the effect of hospital care, [32 52] and "it matters a lot to patients".[53] Patient mortality rates in Norwegian hospitals and the variation between hospitals is lower than in other OECD countries.[54] However, some Norwegian hospitals have mortality rates significantly higher than the national average. Although a significant part of the variation observed in hospital mortality can be explained by differences in the case-mix and to random variation, it has been suggested that as much as 30-60% of this variation can be attributed to differences in the practices and quality of patient care.[55] Some hospitals have structures and processes that minimize avoidable patient deaths better than others.[56] Studying these high performing hospitals can be valuable as they provide deeper insights about which factors are most important for organizational success and reliability.[57]

Our study have several limitations. First, the lack of available, detailed data on the severity of the patient's illnesses at the time of their hospital admission. Our data was case-mix adjusted for age, gender, comorbidity, and the number of previous hospitalizations two years before the present admission, but not, for the disease severity of each diagnosis. Accordingly, it is challenging to distinguish between patients who may have died from the severity of their illness and less severe cases, for whom the lack of high-quality care ultimately may have reduced their chances of survival.

Second, the study design did not allow the linking of nurse, physician and middle manager' care culture evaluation to the survival of the individual patients under their care. That is, we were only able to relate the average staff evaluations to the average patient mortality for each hospital unit. However, we addressed this by using a diagnosis-specific mortality rate that allowed us to link the work environmental perceptions to the hospital wards where the patients were treated for their primary diagnosis. This afforded us the opportunity to dig deeper into our study dataset to examine the robust links between the work environment and patient outcomes.

Third, the previous safety culture literature may also be subject to publication bias.[58] Few randomized controlled studies exist to demonstrate the causal relationships between organizational culture and clinical outcomes. Thus, our findings are important and have

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practical implications. Also, the culture evaluation surveys are susceptible to response bias at both the individual and ward respondent levels, but our response rate of 70-75% compares favorably with those of similar studies.[59] We believe that one should consider other methodologies (qualitative/ethnographic) as useful tools for a deeper exploration of the informal work cultures of the high and low performing wards in our study and how they might affect the success of these hospital wards.[60 61]

Because all the analyses are conducted at the hospital ward level, our sample of 56 wards is relatively small to detect statistical significance, making the size and direction of the correlation coefficients more informative in this context. Although the included hospitals represent nearly half of all Norwegian hospital beds, Norway is a small country and the limited number of units prevents complex multi-variate analyses. This could mean that the variables that could have explained the mortality variation could not be controlled for. We cannot rule out the possibility that the associations we observed may therefore be non-causal.

Finally, our study reflects the context and distinct constraints of the Norwegian healthcare delivery systems, which may be different from other healthcare systems. Norwegian employees generally perceive their work environment as more positive than staff in other countries,[35] and patient survival is relatively high.[54] The study, however, probably carries relevance for the population as a whole, and has strong external generalizability to other countries, because it stems from a large and diverse sample of hospitals.

CONCLUSIONS

Patients fare better in hospitals in which employees declare a supportive and nurturing place to work. Our data suggest that if nurses feel supported, and managers feel engaged in their work, these organizational features of care delivery systems can affect patient hospital mortality. A deeper understanding of these cultural and organizational influences, and how they can increase the performance toward achieving the overall organization goals, is critical to developing meaningful interventions to improve patient outcomes. Assessment of these organizational and cultural metrics might be quite useful in monitoring the safety of hospitals and supporting hospital quality improvement efforts.

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Table 1. Work Environment Factors and Survey Items

DOMAIN SCALE	ITEMS
GOALS	The unit goals are well known to all employees
	I know how I can contribute to the unit to reach its goals
	We regularly evaluate our achievements according to our goals
IMPROVEMENT	In my unit, we do well in reporting and follow up on adverse events
	It is safe to report adverse events in my/this unit
	We openly discuss adverse events and learn from them
	In this unit, we encourage each other to think of ways to do things better
QUALITY	In my unit different professions collaborate well
	We work efficiently in my unit
	In my unit high quality is maintained
PATIENT CENTERED	In my unit, we listen to the views of patients/clients
	In my unit, we are available to patients/clients
	In my unit, sufficient information is given to patients/clients
RESPECT	In my unit, we respect patients/clients cultural background and religion
	In my unit, we comply to keep appointments made
	In my unit, we communicate clearly and in an understandable way
MOTIVATION	Is your work challenging in a positive way
	My work tasks engage me
	The work is so interesting in itself that it is strongly motivating
ENGAGEMENT	Do you look forward going to work
	How often does dissatisfaction with your work make you want to change employer
	Overall, how satisfied are you with the work you do now
COMMITMENT	To my friends, I praise this organization as a great place to work
	This organization inspires me to give my very best job performance
	I am proud of my workplace
PERSONAL DEVELOPEMENT	I can develop professionally through my work
	I get sufficient training and advice to do a good job
	Is your work organized in a way that lets you improve your abilities
	Do you get feedback about the quality of the work you do
EMPOWERMENT	Are you encouraged to participate in decision making
	Are you encouraged to speak up when you have a different opinion
ROLE EXPECTATIONS	Do you know what your responsibilities are
	Do you know what is expected of you at work
SOCIAL CLIMATE	Is the social climate in your unit characterized by a team spirit
	If needed, can you get support and help from your coworkers
	Do you perceive good collaboration in your unit
	Have you observed anyone being harassed or bullied at your workplace during the last six months
	Have you noticed disruptive conflicts in your unit

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	When conflicts occur, are they handled in a professional manner
WORKLOAD	Is the physical load of your work too burdensome Is your work pace challenging Is your workload challenging Do you perform work tasks for which you need more training
AUTONOMY	Can you influence the amount of work assigned to you Can you set your own work pace
ROLE CONFLICTS	Do you have to perform procedures which you feel should be done differently Are you given assignments without adequate resources to complete them Do you receive incompatible requests
SICK LEAVE	Issues at work have contributed to my sick leaves during the last 12 months
LEADERSHIP	My immediate superior is available to me when I need it My immediate superior does an excellent job of giving us information about what goes on in our organization My immediate superior makes clear performance demands My immediate superior adheres to what we have agreed upon If I were subjected to violence or threats, I could count on the support of my immediate superior If I were sick for a more extended period, I could count on the support of my immediate superior
PATIENT SAFETY CULTURE	I would feel safe if I was a patient here Adverse medical events are appropriately handled here

Table 2. Description of Survey Respondents by Age and Profession

	N	Age					Permanent employment	Female
		<30	30-39	40-49	50-59	60+		
Physician	2195	5.5%	40.7%	25.7%	17.9%	10.3%	68.9%	44.3%
Nurses	5602	15.3%	27.4%	26.2%	25.0%	6.1%	92.2%	90.9%
Managers	1036	0.7%	13.0%	33.7%	41.0%	11.6%	96.9%	68.1%

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Table 3. Description of Patients and Clinical Outcomes

	Acute Myocardial Infarction (first time)	Stroke	Hip Fracture (>65 years)
Number of Patients	17734	14442	13850
Number of admissions	17734	15235	14427
Death within 7 days, unadjusted	1234 (7.0%)	1180 (7.7%)	399 (2.8%)
Death within 30 days, unadjusted	2030 (11.4%)	2167 (14.2%)	1314 (9.1%)
Mean length of stay (days)	7.0	10.2	7.2
Treated in two or more hospitals	10412 (58.7%)	1915 (12.6%)	1252 (8.7%)
Gender, female	6785 (38.3%)	7297 (47.9%)	10297 (71.4%)
Age, mean	71.0	74.6	83.4
0-17 years	0 (0.0%)	0 (0.0%)	0 (0.0%)
18-49 years	1411 (8.0%)	777 (5.1%)	0 (0.0%)
50-75 years	8854 (49.9%)	6234 (40.9%)	2549 (17.7%)
>75 years	7469 (42.1%)	8224 (54.0%)	11878 (82.3%)
Number of previous hospitalization during last two years, mean	5.8	5.8	5.9
0	3786 (21.3%)	2432 (16.0%)	1652 (11.5%)
1	2799 (15.8%)	2181 (14.3%)	2069 (14.3%)
2	2189 (12.3%)	1914 (12.6%)	2008 (13.9%)
3-5	4130 (23.3%)	3922 (25.7%)	4142 (28.7%)
6+	4830 (27.2%)	4786 (31.4%)	4556 (31.6%)
Charlson comorbidity index, mean	1.5	1.3	1.8
0 points	8827 (49.8%)	8131 (53.4%)	5914 (41.0%)
1 points	1646 (9.3%)	1658 (10.9%)	1404 (9.7%)

2 points	3096 (17.5%)	2638 (17.3%)	3493 (24.2%)
3+ points	4165 (23.5%)	2808 (18.4%)	3616 (25.1%)

Table 4. Organizational Factor Score Averages by Professions in 56 Hospital Units

Measures	Nurse Mean	SD	Physician Mean	SD	Manager Mean	SD
Goals	62	7	63	9	72	8
Improvement	65	6	69	7	76	6
Quality and efficiency	77	6	77	8	78	8
Patient-centered	76	6	76	6	77	6
Respect for patients	74	4	74	6	76	6
Motivation	75	5	78	7	82	5
Engagement	76	7	75	8	81	7
Commitment	75	9	71	10	81	7
Personal development	62	7	63	8	70	9
Empowerment	55	6	60	9	74	9
Role expectations	89	3	85	6	88	5
Social interactions	83	6	79	8	81	7
Conflicts and bullying	75	5	73	9	81	7
Workload	52	9	54	7	62	7
Autonomy	39	7	38	7	46	9
Role conflicts	68	5	66	7	64	9
Sick leave	86	6	93	8	94	8
Leadership	74	9	75	9	77	12
Patient safety culture	78	8	85	7	90	7

Table 5. Association between Organizational Factors and 7-day mortality

Relative 7-day mortality (2010-2012) Diagnosis-specific*	Nurse		Physician		Managers	
	Beta (95% CI)	p-value	Beta (95% CI)	p-value	Beta (95% CI)	p-value
Goals	0.008 (-0.006, 0.022)	0.245	0.007 (-0.003, 0.019)	0.204	0.009 (-0.003, 0.021)	0.139
Improvement	0.011 (-0.005, 0.027)	0.189	0.008 (-0.007, 0.023)	0.305	0.012 (-0.004, 0.027)	0.130
Quality	0.017 (-0.001, 0.034)	0.057	0.004 (-0.008, 0.016)	0.481	0.014 (0.001, 0.027)	0.032
Patient centered	0.023 (0.007, 0.039)	0.005	0.001 (-0.015, 0.017)	0.882	0.014 (-0.001, 0.030)	0.075
Respect	0.035 (0.013, 0.057)	0.002	0.005 (-0.013, 0.023)	0.577	0.015 (-0.002, 0.031)	0.077
Motivation	0.024 (0.004, 0.044)	0.022	-0.004 (-0.019, 0.010)	0.53	0.028 (0.010, 0.045)	0.002
Engagement	0.021 (0.007, 0.036)	0.005	-0.006 (-0.019, 0.008)	0.407	0.024 (0.010, 0.037)	0.001
Commitment	0.015 (0.004, 0.026)	0.009	-0.004 (-0.017, 0.009)	0.537	0.018 (0.004, 0.031)	0.010
Personal development	0.012 (-0.002, 0.025)	0.094	-0.002 (-0.017, 0.014)	0.826	0.018 (0.007, 0.029)	0.001
Empowerment	0.010 (-0.006, 0.025)	0.231	0.000 (-0.012, 0.011)	0.948	0.011 (0.001, 0.022)	0.037
Role expectations	0.039 (0.004, 0.074)	0.031	0.003 (-0.014, 0.019)	0.750	0.011 (-0.008, 0.031)	0.236
Social climate	0.012 (-0.006, 0.030)	0.194	-0.008 (-0.020, 0.004)	0.211	0.019 (0.006, 0.031)	0.005
Conflicts and bullying	0.003 (-0.017, 0.023)	0.765	-0.009 (-0.021, 0.002)	0.111	0.010 (-0.005, 0.026)	0.180
Workload	0.019	<0.001	-0.002	0.742	0.018	0.006

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	(0.009, 0.028)		(-0.016, 0.012)		(0.005, 0.031)	
Autonomy	0.021 (0.006, 0.035)	0.007	-0.005 (-0.019, 0.009)	0.496	0.009 (-0.002, 0.021)	0.106
Role conflicts	0.027 (0.009, 0.046)	0.004	0.002 (-0.012, 0.016)	0.786	0.015 (0.004, 0.026)	0.010
Sick leave	0.021 (0.006, 0.036)	0.007	-0.003 (-0.017, 0.010)	0.656	0.009 (-0.003, 0.021)	0.125
Leadership	0.011 (0.000, 0.022)	0.045	0.002 (-0.010, 0.014)	0.726	0.008 (-0.001, 0.017)	0.067
Patient safety climate	0.017 (0.006, 0.029)	0.003	0.005 (-0.009, 0.020)	0.449	0.003 (-0.013, 0.018)	0.717

* The relative 7-day survival rates (2010-2012) were adjusted for age, gender, number of hospitalizations during the previous two years and a Charlson Comorbidity index score.

** All analyses were adjusted for diagnoses and the annual number of treatments on each hospital ward.

*** Statistical significance at the $P< 0.05$ level.

**** Results in red indicate statistical significance.

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Footnotes

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Ethical approval: The study was approved by the Medical and Health Research Ethics Committee (REC) in South Eastern Norway with waiver of informed consent, since all data used in the study were anonymous. (Case number 2011/2345 D)

Data availability: No additional data available

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STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No.	Recommendation	Page No.	Relevant text from manuscript
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1	Associations between Work Satisfaction, Engagement, and Seven-day Patient Mortality: a Cross-Sectional Survey.
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2	
Introduction				
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4	
Objectives	3	State specific objectives, including any prespecified hypotheses	4	Our hypothesis was that there is an association between work environment and mortality, and that this association is profession-specific for nurses, physicians and middle managers.
Methods				
Study design	4	Present key elements of study design early in the paper	5	
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5,6,7	
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	5,6,7	All the health professionals who were employed for more than three months in the hospital were eligible for participation. * All adult patients admitted to hospital with AMI, stroke (>18

				years) and hip-fracture (>65 years).
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed		
		Case-control study—For matched studies, give matching criteria and the number of controls per case	NA	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5,6,7	
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7	The patient hospital ward level data were made available on work environment scores from the HSO, and the patient mortality rates were from the NOKC for a three-year period (2010-2012) were combined using the hospital ward names as an identifier.
Bias	9	Describe any efforts to address potential sources of bias	6,7	The mortality rate was risk adjusted for age, gender, and the Charlson Comorbidity index scores based on the patients' admissions to hospitals, three years prior to admission, type of stroke (cerebral hemorrhage /cerebral infarct) and by the total number of hospitalizations

				during the previous two years. Diagnosis-specific outcomes were aggregated over the three years (2010-2012) to ensure there was adequate statistical power.
Study size	10	Explain how the study size was arrived at	5,7	All adult patients with the indicated diagnoses were included. All staff responding to the survey and stating their profession as nurse, physician or middle manager were included.

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Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7	$Relative\ mortality\ rate_{unit} = \dfrac{Mean\ mortality\ rate_{patient\ gro...}}{Mean\ mortality\ r...}$	
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8		
		(*b*) Describe any methods used to examine subgroups and interactions	NA		
		(*c*) Explain how missing data were addressed	NA		
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed			
		Case-control study—If applicable, explain how matching of cases and controls was addressed			
		Cross-sectional study—If applicable, describe analytical methods taking account of sampling strategy	NA		
		(*e*) Describe any sensitivity analyses	NA		
Results					
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	5,6		
		(b) Give reasons for non-participation at each stage	NA	All are included.	
		(c) Consider use of a flow diagram			
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	15,16	See Tables 2 and 3	
		(b) Indicate number of participants with missing data for each variable of interest	8	Only 78% of participants stated their profession. Due to anonymity, we have no information about who did not provide this information.	
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)			
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time			
		Case-control study—Report numbers in each exposure category, or summary measures of exposure			
		Cross-sectional study—Report numbers of outcome events or summary measures	17,18	See Tables 4 and 5	

Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	18	See Table 5 Adjusted for diagnosis and the annual number of treatment on each ward.
		(*b*) Report category boundaries when continuous variables were categorized	NA	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA	

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Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA	
Discussion				
Key results	18	Summarise key results with reference to study objectives	10	The major findings of this study are the strong associations between the organizational work environment and seven-day patient mortality.
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	12	
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13	
Generalisability	21	Discuss the generalisability (external validity) of the study results	13	
Other information				
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	NA	

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.