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# BMJ Open

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

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Manuscripts

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3 **Associations between Work Satisfaction, Engagement, and Seven-day Patient**  
4 **Mortality: a Cross-Sectional Survey**  
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39 Patient safety, work environment, patient outcome  
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47 **Abstract**  
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49 **IMPORTANCE** The clinical work environment and organizational culture can affect patient  
50 outcomes.  
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53 **OBJECTIVE** To evaluate the impact of professional roles and environmental work factors on  
54 the seven-day mortality of patients admitted with Acute Myocardial Infarction (AMI), stroke  
55 and hip fracture.  
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3 **DESIGN** Results of a large cross-sectional validated survey of Norwegian hospital health care  
4 provider' work environment are linked to patient survival data.  
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8 **SETTING** 8,800 survey responses from physicians, nurses, and managers across 56 hospital  
9 wards within 20 hospitals over a three-year period (2010-2012).  
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14 **PARTICIPANTS** Data from 46,000 patients registered in the Norwegian Patient Registry  
15 (2010-2012) admitted with AMI, stroke and hip fracture were included.  
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19 **MAIN OUTCOME AND MEASURES** Seven-day mortality in all the 56 South Eastern Norway  
20 hospital wards in which AMI, stroke and hip fracture patients were treated.  
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25 **RESULTS** Nurse workload (Beta 0.019 (CI<sub>95</sub> 0.009-0.028)) and middle manager engagement  
26 (Beta 0.024 (CI<sub>95</sub> 0.010-0.037)) were associated with a case-mix adjusted seven-day patient  
27 mortality rates. A shift of one standard deviation in the workload scores for nurses or one  
28 standard deviation shift in the engagement scores for the hospital managers corresponds to  
29 a one percent shift in the patient mortality, corresponding to approximately 150 deaths a  
30 year in the studied population.  
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39 **CONCLUSION AND RELEVANCE** Seven-day mortality rates in hospital wards were negatively  
40 correlated with nurse workload and manager engagement. A deeper understanding of the  
41 relationships between patient outcomes, organizational structure, and their underlying  
42 cultural barriers may contribute to the development and implementation of effective and  
43 sustainable hospital system interventions to reduce adverse patient outcomes by improving  
44 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.

Hospitals are complex social-cultural organizations defined by their uncertainty and interdependency.<sup>1</sup> A strong linkage between the organization of care and patient outcomes has been found in several studies.<sup>2,3</sup> 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.<sup>4,5</sup> 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.<sup>6</sup> High-reliability organizational theory posits that organizational features including psychological safety,<sup>7</sup> leadership involvement,<sup>8</sup> team based care,<sup>9</sup> trusting support,<sup>10</sup> and a relentless culture of measurement are needed to sustain improvements in care.<sup>11</sup>

The impact of organizational culture on quality, reporting of data, and safety in non-medical organizations is well documented.<sup>12-15</sup> 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.<sup>16,17</sup> Leggat et al<sup>18</sup> have consistently demonstrated that a reported positive relationship between high-performance workplaces and organizational outcome also applies to patient outcomes in healthcare.<sup>19</sup>

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.<sup>20,21</sup> In other words, organizational culture may be a fundamental determinant of patient outcomes.<sup>22</sup>

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

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7 Data from a three-year period (2010-2012) based on patients admitted with Acute  
8 Myocardial Infarction (AMI), stroke and hip fracture, and the work environment survey  
9 responses from physicians, nurses and middle managers were analyzed. The adjusted  
10 patient mortality rates were calculated by the Norwegian Institute of Public Health based on  
11 patient administrative data<sup>23</sup> and were linked to data from the annual work environment  
12 survey for nurses, doctors and middle managers.  
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18 Definitions and measurements of culture vary. For this study, we defined  
19 organizational culture as the behaviors that emerge based on shared values, beliefs,  
20 assumptions, and norms<sup>12 13 24</sup> Previous research demonstrated more variation in culture  
21 assessments between different clinical wards within the same hospital than between  
22 hospitals.<sup>25</sup> We used the ward level as our level of analyses, as previous studies have shown  
23 that data aggregated at hospital level may mask the unit differences.<sup>26</sup>  
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### 29 **Selection of Hospitals**

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31 The hospitals included in the study varied in size and geographic catchment area, but  
32 had comparable organizational structures, with specially designated wards in each hospital  
33 caring for each of the three groups of patients. Patients admitted with a cerebral stroke  
34 were treated in stroke units according to national guidelines,<sup>27</sup> whereas most patients with a  
35 hip fracture were cared postoperatively in orthopedic wards. Patients with AMI underwent  
36 pre-hospital triage; patients with STEMI infarction are transported directly to PCI centers,  
37 whereas, patients with non-STEMI infarction are admitted to cardiac units at each of the  
38 respective hospitals.  
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### 47 **Patient and Public Involvement**

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49 Patients were not involved in this study, but the results of this study were presented  
50 to the Regional User Committee who supported the study design and its relevance.  
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### 53 **Measurements**

#### 54 ***Survey Data: Work environment and patient safety culture***

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56 The web-based work environment and safety culture data were collected from 2010  
57 to 2012. Nearly 50,000 questionnaires were distributed annually to all employees who had  
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3 been employed for more than three months. Overall response rates for 2010, 2011, and  
4 2012 were 72%, 77%, and 75%, respectively. Seventy-eight percent of the respondents  
5 defined their occupation as physician, nurse or middle manager. In total, 5,602 responses  
6 from nurses, 2,195 from physicians, and 1,036 from middle managers were included in the  
7 analysis. (Table 1)  
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### 13 **Questionnaire**

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

#### 46 *Patient demographics*

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

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57 All 46,026 emergency patients admitted with AMI, stroke, and hip fracture were  
58 included. Seven-day mortality rates were chosen instead of 30-day mortality rates, as a more  
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3 extended observation period might confound the findings and include mortality unrelated to  
4 hospital characteristics, such as variations in post discharge care in local nursing homes and  
5 home healthcare services. The mortality rate was risk adjusted for age, gender, and the  
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7 Charlson Comorbidity index scores based on these patients' admissions to hospital three  
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9 years prior to admission, type of stroke (cerebral hemorrhage/cerebral infarct) and the total  
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11 number of hospitalizations during the previous two years. In the event where a patient  
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13 admission involved more than one hospital, the patient mortality probability was split, based  
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15 on widely accepted methods, between the hospitals according to the fraction of time spent  
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17 at each hospital to reduce possible bias.<sup>30 31</sup> Diagnosis-specific mortality rates were  
18  
19 calculated for all adult patients with the corresponding diagnoses; 17,734 patients admitted  
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21 with first time Acute Myocardial Infarction (AMI) (ICD-10 I21.x), 14,442 cerebral stroke  
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23 patients (ICD-10 I61.63.64), and 13,850 patients admitted over the age of 65 with a hip  
24  
25 fracture (ICD-10 S72.0-2). The relative mortality rates were used as a comparable mortality  
26  
27 rate for all hospital wards among the three diagnosis groups as follows:

$$28$$

$$29 \quad \text{Relative mortality rate}_{unit} = \frac{\text{Mean mortality rate}_{patient\ group} - \text{Mortality rate}_{unit}}{\text{Mean mortality rate}_{patient\ group}}$$

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33 Diagnosis-specific outcomes were aggregated over three years (2010-2012) to ensure  
34  
35 adequate statistical power.

### 36 37 **Statistical Analyses**

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39 The association between the ward work environment and adjusted ward patient  
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41 mortality rates was analyzed using basic descriptive statistics examining for variation by  
42  
43 linear regression. The effects of the different work environment factors were analyzed and  
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45 reported separately, as the limited number of wards studied (n=56) prohibited including all  
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47 explanatory variables in one single multiple predictive model. Backward regression was  
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49 performed to ensure the reliability of our analysis. The work environment effects for  
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51 physicians, nurses and middle managers were analyzed separately to assess how mortality is  
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53 associated with work environment for the three separate professions. The statistical  
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55 significance level was set at .05, and the 95% confidence intervals are presented below. All  
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57 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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2  
3 the reported associations indicates that a shift of one standard deviation in the workload  
4 scores for nurses or one standard deviation shift in the engagement scores for the hospital  
5 managers corresponds to a one percent shift in the patient mortality, corresponding to  
6 approximately 150 deaths a year in the studied population.  
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10 Hospital staff scored their work environment positive (over 70) on a 0-100 scale (100  
11 indicating the most favorable situation), consistent with the general satisfaction reported by  
12 Norwegian employees who report higher job satisfaction than employees in other  
13 countries.<sup>32</sup> However, there were profession-specific differences that may have contributed  
14 to the observed variation in the patient outcomes across the 56 wards. Overall, the middle  
15 managers scored higher than physicians and nurses, and nurses scored lowest on more  
16 organizational factors than managers and physicians.  
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23 Whereas nurses typically worked at one hospital ward, physicians and middle  
24 managers usually worked across several clinical units, and the assessment of their work  
25 environment should be interpreted accordingly. We stress that it is not the physician or  
26 manager perceptions of the patient ward that are being measured, but those of the work  
27 environments of the wards where physicians and middle managers work (entire clinical  
28 departments) supporting these patient wards.  
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34 Twelve of the 19 organizational environmental and workload factors scored by nurses  
35 were significantly associated with seven-day patient mortality suggesting that the nursing  
36 workload associated may be underappreciated.<sup>33</sup> The workload was the most prominent and  
37 derived from survey items such as *“Is the physical load of your work too heavy?”*, *“Is your*  
38 *workload challenging?”* and *“Do you perform work tasks for which you need more training?”*.  
39 These survey items describe the nurse perceptions of their degree of control over the tasks  
40 assigned to them. Our finding supports previous research suggesting that reducing nurse  
41 workload may decrease patient mortality.<sup>34-40</sup>  
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49 As leaders, managers play a central role in building a positive and nurturing a  
50 psychologically safe culture by setting norms and promoting shared *meanings* or shared  
51 *practices*.<sup>41 42</sup> The middle managerial roles, situated between the senior leadership and  
52 front-line workers, offers a unique vantage point from where strategies and policies can be  
53 implemented. At the same time, middle managers are responsible for bringing staff  
54 challenges and needs back to senior management for consideration and action. Managers  
55 can contribute to organizational change by capitalizing on this position,<sup>43</sup> as management  
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3 involvement and engagement have been suggested as a positive influence on care delivery  
4 systems.<sup>8 44 45</sup> At the same time, engagement of top-management and hospital boards in  
5 patient safety initiatives can enhance the middle managers' support for a safety culture that  
6 can, among other things, affect patient mortality.<sup>46</sup>  
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10 We did not find any correlation between patient mortality and physicians' perception  
11 of their work environment. The interpretation does not necessarily mean that physician  
12 work environment is unrelated to patient outcomes. We think this may be a result of  
13 physicians' sense of autonomy<sup>47</sup> and their responsibility covering patients in multiple  
14 departments and service lines simultaneously and this might affect their responses. For  
15 nurses the definition of work environment is more straightforward. Their work is generally  
16 restricted to one ward only, and they will have this ward in mind when responding to work  
17 surveys. Nurses report to, and are assigned tasks by, a supervisor on a daily basis; the same  
18 cannot be said for physicians who have much more autonomy about when and where their  
19 work takes place. This structural difference we believe can lead to a physician-as-manager  
20 philosophy and a nurse-as-employee philosophy in most healthcare organizations. Previous  
21 research has identified differences in culture and work styles within hospitals, and much of  
22 this variance was found to be located at the ward and microsystem levels.<sup>48</sup> The responses  
23 from physicians working on several wards may attenuate these inter-ward differences: their  
24 answers are based on their "average experiences" from several environments. This might  
25 explain the physician lack of significant association by hospital ward.  
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40 We chose to focus on mortality rates as our dependent variable as mortality is well-  
41 defined, easily measured, considered useful for estimating the effect of hospital care,<sup>31 49</sup>  
42 and "it matters a lot to patients".<sup>50</sup> Patient mortality rates in Norwegian hospitals and the  
43 variation between hospitals is lower than in other OECD countries.<sup>51</sup> However, some  
44 Norwegian hospitals have mortality rates significantly higher than the national average.  
45 Although a significant part of the variation seen in the observed hospital mortality can be  
46 explained by differences in the case mix and random variation, it has been suggested that  
47 30-60% can be attributed to differences in the quality of patient care.<sup>52</sup> Some hospitals have  
48 structures and processes that minimize avoidable patient deaths better than others.<sup>53</sup>  
49 Studying these high performing hospitals can be valuable as they provide knowledge about  
50 the learning factors most important for organizational success and reliability.<sup>54</sup>  
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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.<sup>55</sup> 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.<sup>56</sup>

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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3 Norwegian employees generally perceive their work environment as more positive than staff  
4 in other countries,<sup>32</sup> and patient survival is relatively high,<sup>51</sup> but, the study probably carries  
5 relevance for the population as a whole, and to other countries, because it stems from a  
6 large and diverse sample of hospitals.  
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## 10 11 12 **CONCLUSIONS**

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14 Our findings suggest a robust connection between organizational features of care  
15 delivery systems and bottom-line outcomes such as hospital mortality. Understanding these  
16 influences is critical to developing meaningful intervention strategies to improve patient  
17 outcomes and should be used in the planning of future work. Patients fare better in hospitals  
18 that are described as better places to work. Monitoring the work environment with robust  
19 metrics for psychological safety and engagement would benefit future investigations about  
20 the associations between organizational culture and patient outcomes, staff joy, and patient  
21 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%  |

For peer review only

Table 2. Work Environmental Factors and Culture Survey Items

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



|                        |   |
|------------------------|---|
|                        | 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 3. Description of Patients and Clinical Outcomes

|   | <b>Acute Myocardial infarction (first time)</b> | <b>Stroke</b> | <b>Hip fracture &gt;65 years</b> |
|---|---|---------------|----------------------------------|
| <b>Number of patients</b>   | 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%)                    |
| <b>Age, mean</b>  | 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%)                    |
| <b>Number of previous hospitalization during last two years, mean</b> | 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%)                     |
| <b>Charlson comorbidity index, mean</b>                               | 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<br>(25.1%) |
|-----------|--------------|--------------|-----------------|

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

| Measures               | Nurse |    | Physician |    | Managers |    |
|------------------------|-------|----|-----------|----|----------|----|
|                        | 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  |

Table 5. Relationship between Organizational Factors and Patient Outcomes

| Relative<br>7-day<br>mortality<br>(2010-<br>2012)<br>Diagnosis<br>-specific* | Nurse unadjusted                |              | Physician unadjusted             |         | Managers<br>unadjusted      |              |
|--|---------------------------------|--------------|----------------------------------|---------|-----------------------------|--------------|
|  | Beta (95%<br>CI)                | p-<br>value  | Beta<br>(95% CI)                 | p-value | Beta (95%<br>CI)            | p-<br>value  |
| Goals  | 0.008<br>(-<br>0.006,0.0<br>22) | 0.245        | 0.007<br>(-<br>0.003,0.0<br>19)  | 0.204   | 0.009<br>(-<br>0.003,0.021) | 0.139        |
| Improve<br>ment  | 0.011<br>(-<br>0.005,0.0<br>27) | 0.189        | 0.008<br>(-<br>0.007,0.0<br>23)  | 0.305   | 0.012<br>(-<br>0.004,0.027) | 0.130        |
| Quality  | 0.017<br>(-<br>0.001,0.0<br>34) | 0.057        | 0.004<br>(-<br>0.008,0.0<br>16)  | 0.481   | 0.014<br>(0.001,0.027<br>)  | <b>0.032</b> |
| Patient<br>centered  | 0.023<br>(0.007,0.0<br>39)      | <b>0.005</b> | 0.001<br>(-<br>0.015,0.0<br>17)  | 0.882   | 0.014<br>(-<br>0.001,0.030) | 0.075        |
| Respect  | 0.035<br>(0.013,0.0<br>57)      | <b>0.002</b> | 0.005<br>(-<br>0.013,0.0<br>23)  | 0.577   | 0.015<br>(-<br>0.002,0.031) | 0.077        |
| Motivatio<br>n   | 0.024<br>(0.004,0.0<br>44)      | <b>0.022</b> | -0.004<br>(-<br>0.019,0.0<br>10) | 0.53    | 0.028<br>(0.010,0.045<br>)  | <b>0.002</b> |
| Engagem<br>ent   | 0.021<br>(0.007,0.0<br>36)      | <b>0.005</b> | -0.006<br>(-<br>0.019,0.0<br>08) | 0.407   | 0.024<br>(0.010,0.037<br>)  | <b>0.001</b> |
| Commitm<br>ent   | 0.015<br>(0.004,0.0<br>26)      | <b>0.009</b> | -0.004<br>(-<br>0.017,0.0<br>09) | 0.537   | 0.018<br>(0.004,0.031<br>)  | <b>0.010</b> |
| Personal<br>develop<br>ment  | 0.012<br>(-<br>0.002,0.0<br>25) | 0.094        | -0.002<br>(-<br>0.017,0.0<br>14) | 0.826   | 0.018<br>(0.007,0.029<br>)  | <b>0.001</b> |

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

## References

1. Snowden DJ, Boone ME. A Leaders Framework for Decision Making-Wise executive tailor their approach to fit the complexity of the circumstances they face. *Harvard Business Review* 2007;85(11):68-+.
2. Mitchell PH, Shortell SM. Adverse Outcomes and Variations in Organization of Care Delivery. *Medical Care* 1997;35(11):NS19-NS32.
3. Kohn LT, Corrigan JM, Donaldson M. To Err is Human: Building a Safer Health System. Washington, D.C.: National Academy Press 1999.
4. Craig P, Dieppe P, Macintyre S, et al. Developing and evaluating complex interventions: the new Medical Research Council guidance. *BMJ (Clinical research ed)* 2008;337:a1655. doi: 10.1136/bmj.a1655
5. Cassin BR, Barach PR. Making sense of root cause analysis investigations of surgery-related adverse events. *Surgical Clinics* 2012;92(1):101-15.
6. Soop M, Fryksmark U, Köster M, et al. The incidence of adverse events in Swedish hospitals: a retrospective medical record review study. *International journal for quality in health care* 2009;21(4):285-91.
7. Rosenbaum L. Cursed by Knowledge—Building a Culture of Psychological Safety: Mass Medical Soc, 2019.
8. Parand A, Dopson S, Renz A, et al. The role of hospital managers in quality and patient safety: a systematic review. *BMJ open* 2014;4(9):e005055.
9. Salas E, Baker D, King H, et al. On Teams, Organizations, and Safety: Of Course.... *Joint Commission Journal on Quality and Patient Safety* 2006;32(2):112-13.
10. Frankel RM, Tilden VP, Suchman A. Physicians' Trust in One Another. *JAMA* 2019
11. Lawton R, Taylor N, Clay-Williams R, et al. Positive deviance: a different approach to achieving patient safety. *BMJ quality & safety* 2014:bmjqs-2014-003115.
12. Schein EH. Organizational culture and leadership: John Wiley & Sons 2010.
13. Bolman LG, Deal TE. Reframing organizations: Artistry, choice, and leadership: John Wiley & Sons 2003.
14. Barach P, Small SD. How the NHS can improve safety and learning: by learning free lessons from near misses: British Medical Journal Publishing Group, 2000.
15. Macrae C, Stewart K. Can we import improvements from industry to healthcare? *bmj* 2019;364:l1039.
16. Hall LH, Johnson J, Watt I, et al. Healthcare staff wellbeing, burnout, and patient safety: A systematic review. *PLoS One* 2016;11(7):e0159015.
17. Barach P, Phelps G. Clinical sensemaking: a systematic approach to reduce the impact of normalised deviance in the medical profession. *Journal of the Royal Society of Medicine* 2013;106(10):387-90.
18. Leggat SG, Bartram T, Casimir G, et al. Nurse perceptions of the quality of patient care: Confirming the importance of empowerment and job satisfaction. *Health Care Management Review* 2010;35(4):355-64.
19. Braithwaite J, Herkes J, Ludlow K, et al. Association between organisational and workplace cultures, and patient outcomes: systematic review. *BMJ open* 2017;7(11):e017708.
20. Karsh B, Holden R, Alper S, et al. A human factors engineering paradigm for patient safety: designing to support the performance of the healthcare professional. *Quality and Safety in Health Care* 2006;15(suppl 1):i59-i65.
21. Wahr JA, Prager RL, Abernathy III J, et al. Patient safety in the cardiac operating room: human factors and teamwork: a scientific statement from the American Heart Association. *Circulation* 2013;128(10):1139-69.
22. Francis R. Report of the Mid Staffordshire NHS Foundation Trust public inquiry: executive summary: The Stationery Office 2013.

23. Helgeland J KD, Hassani S, Lindman AS. Overlevelse og reinnleggelse ved norske sykehus for 2012. Oslo: Nasjonalt kunnskapssenter for helsetjenesten, 2013.
24. Brown A. Organizational culture: The key to effective leadership and organizational development. *Leadership & Organization Development Journal* 1992;13(2):3-6.
25. Hudson DW, Berenholtz SM, Thomas EJ, et al. A safety culture Primer for the critical care Clinician. *Contemporary Critical Care* 2009;7(5):1-11.
26. Deilkås E, Hofoss D. Patient safety culture lives in departments and wards: multilevel partitioning of variance in patient safety culture. *BMC health services research* 2010;10(1):85.
27. B I. Nsjonale fagligretningslinje for behandling og rehabilitering ved hjerneslag 2018 [3.1.2018].
28. Wännström I, Peterson U, Åsberg M, et al. Psychometric properties of scales in the General Nordic Questionnaire for Psychological and Social Factors at Work (QPSNordic): Confirmatory factor analysis and prediction of certified long-term sickness absence. *Scandinavian journal of psychology* 2009;50(3):231-44.
29. Huang DT, Clermont G, Kong L, et al. Intensive care unit safety culture and outcomes: a US multicenter study. *International Journal for Quality in Health Care* 2010;22(3):151-61.
30. Hassani S, Lindman AS, Kristoffersen DT, et al. 30-Day Survival Probabilities as a Quality Indicator for Norwegian Hospitals: Data Management and Analysis. *PloS one* 2015;10(9):e0136547.
31. Kristoffersen DT, Helgeland J, Waage HP, et al. Survival curves to support quality improvement in hospitals with excess 30-day mortality after acute myocardial infarction, cerebral stroke and hip fracture: a before–after study. *BMJ open* 2015;5(3):e006741.
32. Hanglberger D. Arbeitszufriedenheit im internationalen Vergleich: FFB-Diskussionspapier, 2011.
33. Weigl M, Stab N, Herms I, et al. The associations of supervisor support and work overload with burnout and depression: a cross-sectional study in two nursing settings. *Journal of Advanced Nursing* 2016;72(8):1774-88.
34. McHugh MD, Rochman MF, Sloane DM, et al. Better nurse staffing and nurse work environments associated with increased survival of in-hospital cardiac arrest patients. *Medical care* 2016;54(1):74-80.
35. Faisy C, Davagnar C, Ladiray D, et al. Nurse workload and inexperienced medical staff members are associated with seasonal peaks in severe adverse events in the adult medical intensive care unit: A seven-year prospective study. *International Journal of Nursing Studies* 2016;62:60-70.
36. Aiken LH, Clarke SP, Sloane DM, et al. Hospital nurse staffing and patient mortality, nurse burnout, and job dissatisfaction. *Jama* 2002;288(16):1987-93.
37. McHugh MD, Ma C. Hospital nursing and 30-day readmissions among Medicare patients with heart failure, acute myocardial infarction, and pneumonia. *Medical care* 2013;51(1):52.
38. Kane RL, Shamliyan TA, Mueller C, et al. The association of registered nurse staffing levels and patient outcomes: systematic review and meta-analysis. *Medical care* 2007;45(12):1195-204.
39. Carayon P, Gurses AP. Nursing workload and patient safety—a human factors engineering perspective. 2008
40. Tvedt C, Sjetne IS, Helgeland J, et al. An observational study: associations between nurse-reported hospital characteristics and estimated 30-day survival probabilities. *BMJ quality & safety* 2014;23(9):757-64. doi: 10.1136/bmjqs-2013-002781
41. West MA, Borrill C, Dawson J, et al. The link between the management of employees and patient mortality in acute hospitals. *International Journal of Human Resource Management* 2002;13(8):1299-310.
42. Edmondson A, Moingeon B. Learning, trust and organizational change. *Organizational learning and the learning organization* 1999:157-75.
43. Gutberg J, Berta W. Understanding middle managers' influence in implementing patient safety culture. *BMC health services research* 2017;17(1):582.
44. West M, Dawson J. Employee engagement and NHS performance: King's Fund London 2012.
45. Veronesi G, Kirkpatrick I, Altanlar A. Are Public Sector Managers a “Bureaucratic Burden”? The Case of English Public Hospitals. *Journal of Public Administration Research and Theory* 2018

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3 46. Conway J. Getting boards on board: engaging governing boards in quality and safety. *The Joint*  
4 *Commission Journal on Quality and Patient Safety* 2008;34(4):214-20.  
5  
6 47. Amalberti R, Auroy Y, Berwick D, et al. Five system barriers to achieving ultrasafe health care.  
7 *Annals of internal medicine* 2005;142(9):756-64.  
8 48. Deilkas E, Hofoss D. Patient safety culture lives in departments and wards: multilevel partitioning  
9 of variance in patient safety culture. *BMC Health Services Research* 2010;10:85.  
10 49. Borzecki AM, Christiansen CL, Chew P, et al. Comparison of In-Hospital Versus 30-Day Mortality  
11 Assessments for Selected Medical Conditions. *Medical Care* 2010;48(12):1117-21. doi:  
12 10.1097/MLR.0b013e3181ef9d53  
13 50. Krumholz HM, Wang Y, Mattera JA, et al. An administrative claims model suitable for profiling  
14 hospital performance based on 30-day mortality rates among patients with an acute  
15 myocardial infarction. *Circulation* 2006;113(13):1683-92.  
16 51. Publishing O. Health at a glance 2013: OECD indicators: OECD publishing 2013.  
17 52. Cecil E, Wilkinson S, Bottle A, et al. National hospital mortality surveillance system: a descriptive  
18 analysis. *BMJ quality & safety* 2018:bmjqs-2018-008364.  
19 53. Tourangeau AE, Cranley LA, Jeffs L. Impact of nursing on hospital patient mortality: a focused  
20 review and related policy implications. *Quality and Safety in Health Care* 2006;15(1):4-8. doi:  
21 10.1136/qshc.2005.014514  
22 54. Taylor N, Clay-Williams R, Hogden E, et al. High performing hospitals: a qualitative systematic  
23 review of associated factors and practical strategies for improvement. *BMC health services*  
24 *research* 2015;15(1):244.  
25 55. Longitudinal study evaluating the association between physician burnout and changes in  
26 professional work effort. *Mayo Clinic Proceedings*; 2016. Elsevier.  
27 56. Bognár A, Barach P, Johnson JK, et al. Errors and the burden of errors: attitudes, perceptions, and  
28 the culture of safety in pediatric cardiac surgical teams. *The Annals of Thoracic Surgery*  
29 2008;85(4):1374-81.  
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### Footnotes

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4 study from approval since all data used in the study were anonymous.  
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# BMJ Open

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

Word Count: 3414

## 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<sub>95</sub> 0.009-0.028)) and middle manager engagement (Beta 0.024 (CI<sub>95</sub> 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.

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

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

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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.<sup>20,21</sup> In other words, the  
organizational culture may be a fundamental determinant of patient outcomes.<sup>22</sup>

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.

## 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.<sup>23</sup>

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)<sup>24</sup> 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.<sup>25</sup> 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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3 with missing data were excluded from the analysis. A report with the mean average score  
4 on each item and factor in the survey for each ward was produced and made public. Nurses  
5 work on one hospital ward and responses were allocated to the specific ward. Physicians and  
6 middle managers cover several wards or units. It is the perceptions about the work  
7 environments where physicians and middle managers work (entire clinical departments)  
8 supporting these patient wards that is measured.  
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15 The definitions and measurements of culture vary. For this study, we defined  
16 organizational culture as the behaviors that emerge based on shared values, beliefs,  
17 assumptions, and norms.<sup>12 13 26</sup> Previous research demonstrated more variation in culture  
18 assessments between different clinical wards within the same hospital than between the  
19 hospitals.<sup>27</sup> We used the ward level as our level of analyses, as previous studies have shown  
20 that data aggregated at hospital level may mask the hospital unit's differences.<sup>28</sup>  
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26 Norwegian Knowledge Centre for the Health Services (NOKC) reports hospital survival  
27 probabilities for 46.026 patients with AMI, stroke, hip-fracture, and a hospital-wide survival  
28 rate quality indicator for Norwegian hospitals.<sup>29</sup> The mortality rates are estimated based on  
29 all-cause death, tracking patients with their unique Personal Identification Number. The  
30 mortality rate was risk-adjusted for age, gender, and the Charlson Comorbidity index scores  
31 based on the patients' hospital admissions three years prior to their admission, type of  
32 stroke (cerebral hemorrhage/cerebral infarction) and the total number of hospitalizations  
33 during the previous two years. In the event where a patient admission involved more than  
34 one hospital, the patient mortality probability was split between the hospitals according to  
35 the time the patient spent at each hospital in order to reduce possible bias. The data  
36 management and analysis is described by Hassani et al.<sup>30 31</sup> This study used risk adjusted  
37 patient data from NOKC for patients admitted to hospitals with AMI, stroke and hip-fracture.  
38 The seven-day mortality rate was chosen to study the possible associations between the  
39 work environment and mortality for high-risk patients in hospital. A more extended  
40 observation period might confound the findings and include mortality unrelated to hospital  
41 characteristics, such as variations in post discharge care at local nursing homes and home  
42 healthcare services. The ward mortality rate was calculated for the patients with the  
43 included diagnosis only, and not, combined with the mortality of patients with other  
44 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:

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

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,<sup>32</sup> 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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3 using a linear regression model that was adjusted for diagnosis and the annual number of  
4 treatments. The effects of the different work environmental factors were analyzed and  
5 reported separately, as the limited number of wards studied (n=56) prohibited including all  
6 explanatory variables in one single multiple predictive model. A backward conditional  
7 regression analysis was performed by including all the significant work environmental factors  
8 from the initial separate analysis (Nurses: Patient centered, Respect, Motivation,  
9 Engagement, Commitment, Role expectations, Workload, Autonomy, Role conflicts, Sick  
10 leave, Leadership, Patient safety climate; Physicians: None; Managers: Quality, Motivation,  
11 Engagement, Commitment, Personal development, Empowerment, Social climate,  
12 Workload, Role conflicts). The level for removal of variables was set to  $P>0.05$ . The work  
13 environment effects for physicians, nurses and middle managers were analyzed separately  
14 to assess how patient mortality is associated with the work environment for the three  
15 separate professions. The statistical significance level was set at 0.05, and the 95%  
16 confidence intervals are presented below. All statistical analyses were carried out using the  
17 IBM SPSS statistical package Version 21.  
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### 33 **Patient and Public Involvement**

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35 The study protocol and the results of this study have been presented for the Regional  
36 Patient Representative Committee who supported the study design and its relevance.  
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### 41 **RESULTS**

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44 The web-based work environment and safety culture data were collected from 2010  
45 to 2012. Nearly 50,000 questionnaires were distributed annually. The response rates for  
46 2010, 2011, and 2012 were 72%, 77%, and 75%, respectively. The background information  
47 such as gender, age and profession was stated voluntarily. Seventy-eight percent of the  
48 respondents defined their occupation. In total, 5,602 responses from nurses, 2,195 from  
49 physicians, and 1,036 from middle managers were included in the analysis. (Table 2)  
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55 All emergency patients admitted with AMI, stroke, and hip-fracture were included.  
56 Diagnosis-specific mortality rates were calculated for all adult patients (age>18) with the  
57 corresponding diagnoses; 17,734 patients admitted with first time acute myocardial  
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3 infarction (AMI) (ICD-10 I21.x), 14,442 cerebral stroke patients (ICD-10 I61.63.64), and  
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5 13,850 patients admitted over the age of 65 with a hip-fracture (ICD-10 S72.0-2). The  
6  
7 average length of hospital stay for the patients included in the study was 8.1 days. The  
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9 seven-day mortality rate varied from 2.8% - 7.7%. The mean Charlson Comorbidity Index  
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11 score was 1.5. (Table 3)

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

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23 Hospital staff rated their work environment, in general, positively on the 0-100 scale  
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25 (100 indicating the most favorable condition): the mean scores for nurses, physicians, and  
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27 middle managers were 70.5, 67.2 and 76.3, respectively. The middle managers reported  
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29 higher scores than physicians and nurses on all but three of the 19 organizational factors,  
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31 while the nurses scored lower than managers and physicians on nine of the 19 factors. The  
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33 mean scores and standard deviation for each factor by profession are presented in Table 4.  
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35 Table 5 shows that several factors were significantly associated with patient mortality  
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37 probabilities. The backward regression model demonstrated that a higher perceived  
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39 workload by nurses was significantly associated with patient mortality: beta = 0.019 (CI<sub>95</sub>  
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41 0.009, 0.028). Nurses: Workload  $P < 0.001$ , Respect  $P = 0.002$ , Patient safety culture  $P = 0.003$ ,  
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43 Role conflicts  $P = 0.004$ , Patient centered  $P = 0.005$ , Engagement  $P = 0.005$ , Autonomy  $P = 0.007$ ,  
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45 Sick leave  $P = 0.007$ , Commitment  $P = 0.009$ , Motivation  $P = 0.022$ , Role expectation  $P = 0.031$ ,  
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47 Leadership  $P = 0.045$ . For middle managers, engagement was significantly associated with  
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49 seven-day mortality: beta= 0.024 (CI<sub>95</sub> 0.010, 0.037). Middle managers: Engagement  
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51  $P = 0.001$ , Personal development  $P = 0.001$ , Motivation  $P = 0.002$ , Social climate  $P = 0.005$ ,  
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53 Workload  $P = 0.006$ , Commitment  $P = 0.010$ , Role conflict  $P = 0.010$ . No significant association  
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55 was found between the physician reported work environment scores and patient mortality.

## 56 57 **DISCUSSION**

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59 The major findings of this study are the correlations between organizational work  
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environment and seven-day patient mortality. This study extends findings in the literature

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3 demonstrating that the work environment at the 20 hospitals in the South Eastern Norway  
4 Health Region were significantly related to their reported seven-day mortality for patients  
5 admitted with AMI, stroke and hip-fractures. We observed a significant increase in patient  
6 mortality in hospital units where nurses reported excessive workload and middle managers  
7 reported a lack of professional and organizational engagement. No such associations were  
8 found between physician reported work environment and patient mortality.  
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14 Hospital staff scored their work environment positive (over 70) on a 0-100 scale (100  
15 indicating the most favorable situation), consistent with the general satisfaction reported by  
16 Norwegian employees who report higher job satisfaction than employees in other  
17 countries.<sup>33</sup> However, there were profession-specific differences that may have contributed  
18 to the observed variation in the patient outcomes across the 56 hospital wards. Overall, the  
19 middle managers scored higher than physicians and nurses, and nurses scored lowest on  
20 more organizational factors than managers and physicians.  
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27 Whereas nurses typically worked on one hospital ward, physicians and middle  
28 managers usually worked across several clinical units, and the assessment of their work  
29 environment should be interpreted accordingly. We stress that it is not the physician or  
30 manager perceptions of the patient ward that are being measured, but the explicit  
31 perceptions about the work environments where physicians and middle managers work  
32 (entire clinical departments) supporting these patient wards.  
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38 Twelve of the 19 organizational environmental and workload factors scored by nurses  
39 were significantly associated with seven-day patient mortality suggesting that the nursing  
40 workload associated may be underappreciated.<sup>34</sup> The workload was the most prominent and  
41 derived from survey items such as *"Is the physical load of your work too heavy?"*, *"Is your*  
42 *workload challenging?"*, and *"Do you perform work tasks for which you need more*  
43 *training?"*. These survey items describe the nurse's perceptions of their degree of control  
44 over the daily tasks assigned to them. Our findings reinforce results from previous studies  
45 suggesting that reducing the nurse workload may decrease patient mortality.<sup>35-41</sup>  
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53 As frontline leaders, managers play a critical role in building and nurturing a  
54 psychologically safe culture by setting the norms of speaking up, and promoting shared  
55 *meanings* and *practices*.<sup>42 43</sup> The middle managerial roles, situated between the senior  
56 hospital management and front-line workers, offers a unique vantage point to implement  
57 and oversee strategies and work policies. At the same time, middle managers are  
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3 responsible for bringing staff concerns and needs back to senior management for  
4 consideration and action. Managers can contribute to organizational change by capitalizing  
5 on this position,<sup>44</sup> as management involvement and engagement have been documented as  
6 a positive influence on care delivery systems.<sup>8 45 46</sup> At the same time, engagement of top-  
7 management and hospital boards in patient safety initiatives can enhance the middle  
8 managers' support for a safety culture that can, among other things, affect patient  
9 mortality.<sup>47</sup>

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

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

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3 60% of this variation can be attributed to differences in the quality of patient care.<sup>53</sup> Some  
4 hospitals have structures and processes that minimize avoidable patient deaths better than  
5 others.<sup>54</sup> Studying these high performing hospitals can be valuable as they provide wisdom  
6 about factors most important for organizational success and reliability.<sup>55</sup>  
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10 Our results must be viewed within the context of the study design. First, the lack of  
11 detailed data available on the severity of the patient's illness at the time of their hospital  
12 admission. Our data was case-mix adjusted for age, gender, comorbidity, and the number of  
13 previous hospitalizations two years before the present admission, but not for the disease  
14 severity of each diagnosis. Accordingly, it is challenging to distinguish between patients who  
15 may have died from the severity of their illness and less severe cases, for whom the lack of  
16 high-quality care ultimately reduced their chances of survival.  
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23 Second, the study design did not allow linking of nurse, physician and middle  
24 manager' care culture evaluation to the survival of the individual patients under their care.  
25 That is, we were only able to relate the average staff evaluations to the average patient  
26 mortality for each unit. However, we addressed this by using a diagnosis-specific mortality  
27 rate that allowed us to link the work environmental perceptions to the hospital wards where  
28 the patients were most likely treated for their primary diagnosis. This afforded us the  
29 opportunity to dig deeper into our study dataset to examine the robust links between the  
30 work environment and patient outcomes. Aggregated hospital data can mask the unit  
31 variation within each hospital.  
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40 Third, the previous safety culture literature may also be subject to publication bias.<sup>56</sup>  
41 Few randomized controlled studies exist to demonstrate causal relationships between safety  
42 culture and clinical outcomes. Thus, our findings are important and have practical  
43 implications. Also, the culture evaluation surveys are susceptible to response bias at both  
44 the individual and ward respondent levels, but our response rate of 70-75% compares  
45 favorably with those of similar studies.<sup>57</sup> We believe that one should consider other  
46 methodologies (qualitative/ethnographic) as useful tools for exploring the informal work  
47 cultures of the high and low performing wards in our study.<sup>58</sup>  
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55 Because all the analyses are conducted at the ward level, our sample of 56 wards is  
56 relatively small to detect statistical significance, making the size and direction of the  
57 correlation coefficients more informative in this context. Although the included hospitals  
58 studied represent nearly half of all Norwegian hospital beds, Norway is a small country and  
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3 the limited number of units prevent complex multivariate analyses. This could mean that the  
4 variables that could have explained the mortality variation could not be controlled for. We  
5 therefore cannot rule out the possibility that the associations we observed may be non-  
6 causal correlations.  
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10 Finally, our study reflects the context and distinct constraints of the Norwegian  
11 healthcare delivery systems, which may be different from other healthcare systems.  
12 Norwegian employees generally perceive their work environment as more positive than staff  
13 in other countries,<sup>33</sup> and patient survival is relatively high,<sup>52</sup> but, the study probably carries  
14 relevance for the population as a whole, and to other countries, because it stems from a  
15 large and diverse sample of hospitals.  
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### 23 **CONCLUSIONS**

24 Patients seem to fare better in hospitals that are described by employees as better  
25 places to work. Our findings suggest a significant correlation between organizational  
26 features of care delivery systems and patient hospital mortality. A deeper understanding of  
27 these influences is critical to developing meaningful interventions to improve patient  
28 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<br>I know how I can contribute to the unit to reach its goals<br>We regularly evaluate our achievements according to our goals  |
| Improvement            | In my unit, we do well in reporting and follow up on adverse events<br>It is safe to report adverse events in my/this unit<br>We openly discuss adverse events and learn from them<br>In this unit, we encourage each other to think of ways to do things better |
| Quality                | In my unit different professions collaborate well<br>We work efficiently in my unit<br>In my unit high quality is maintained   |
| Patient-centered       | In my unit, we listen to the views of patients/clients<br>In my unit, we are available to patients/clients<br>In my unit, sufficient information is given to patients/clients  |
| Respect                | In my unit, we respect patients/clients cultural background and religion<br>In my unit, we comply to keep appointments made<br>In my unit, we communicate clearly and in an understandable way   |
| Motivation             | Is your work challenging in a positive way<br>My work tasks engage me<br>The work is so interesting in itself that it is strongly motivating   |
| Engagement             | Do you look forward going to work<br>How often does dissatisfaction with your work make you want to change employer<br>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<br>This organization inspires me to give my very best job performance<br>I am proud of my workplace   |
| Personal development   | I can develop professionally through my work<br>I get sufficient training and advice to do a good job<br>Is your work organized in a way that lets you improve your abilities<br>Do you get feedback about the quality of the work you do                        |
| Empowerment            | Are you encouraged to participate in decision making<br>Are you encouraged to speak up when you have a different opinion   |
| Role expectations      | Do you know what your responsibilities are<br>Do you know what is expected of you at work  |
| Social climate         | Is the social climate in your unit characterized by a team spirit<br>If needed, can you get support and help from your coworkers<br>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  |



|                        |   |
|------------------------|---|
|                        | 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

|   | <b>Acute Myocardial infarction (first time)</b> | <b>Stroke</b> | <b>Hip fracture &gt;65 years</b> |
|---|---|---------------|----------------------------------|
| <b>Number of patients</b>   | 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%)                    |
| <b>Age, mean</b>  | 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%)                    |
| <b>Number of previous hospitalization during last two years, mean</b> | 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%)                     |
| <b>Charlson comorbidity index, mean</b>                               | 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. Hospital Units Organizational Factor Score Averages by Professions (N=56)

| Measures               | Nurse |    | Physician |    | Managers |    |
|------------------------|-------|----|-----------|----|----------|----|
|                        | 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  |

Table 5. Association between each Organizational Factors and relative seven-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<br>(-0.006,0.022) | 0.245   | 0.007<br>(-0.003,0.019)  | 0.204   | 0.009<br>(-0.003,0.021) | 0.139   |
| Improve ment   | 0.011<br>(-0.005,0.027) | 0.189   | 0.008<br>(-0.007,0.023)  | 0.305   | 0.012<br>(-0.004,0.027) | 0.130   |
| Quality  | 0.017<br>(-0.001,0.034) | 0.057   | 0.004<br>(-0.008,0.016)  | 0.481   | 0.014<br>(0.001,0.027)  | 0.032   |
| Patient centered   | 0.023<br>(0.007,0.039)  | 0.005   | 0.001<br>(-0.015,0.017)  | 0.882   | 0.014<br>(-0.001,0.030) | 0.075   |
| Respect  | 0.035<br>(0.013,0.057)  | 0.002   | 0.005<br>(-0.013,0.023)  | 0.577   | 0.015<br>(-0.002,0.031) | 0.077   |
| Motivatio n  | 0.024<br>(0.004,0.044)  | 0.022   | -0.004<br>(-0.019,0.010) | 0.53    | 0.028<br>(0.010,0.045)  | 0.002   |
| Engagem ent  | 0.021<br>(0.007,0.036)  | 0.005   | -0.006<br>(-0.019,0.008) | 0.407   | 0.024<br>(0.010,0.037)  | 0.001   |
| Commitm ent  | 0.015<br>(0.004,0.026)  | 0.009   | -0.004<br>(-0.017,0.009) | 0.537   | 0.018<br>(0.004,0.031)  | 0.010   |
| Personal develop ment                                    | 0.012<br>(-0.002,0.025) | 0.094   | -0.002<br>(-0.017,0.014) | 0.826   | 0.018<br>(0.007,0.029)  | 0.001   |

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

## References

1. Snowden DJ, Boone ME. A Leaders Framework for Decision Making-Wise executive tailor their approach to fit the complexity of the circumstances they face. *Harvard Business Review* 2007;85(11):68.
2. Mitchell PH, Shortell SM. Adverse Outcomes and Variations in Organization of Care Delivery. *Medical Care* 1997;35(11):NS19-NS32.
3. Kohn LT, Corrigan JM, Donaldson M. To Err is Human: Building a Safer Health System. Washington, D.C.: National Academy Press 1999.
4. Craig P, Dieppe P, Macintyre S, et al. Developing and evaluating complex interventions: the new Medical Research Council guidance. *BMJ (Clinical research ed)* 2008;337:a1655. doi: 10.1136/bmj.a1655
5. Cassin BR, Barach PR. Making sense of root cause analysis investigations of surgery-related adverse events. *Surgical Clinics* 2012;92(1):101-15.
6. Soop M, Fryksmark U, Köster M, et al. The incidence of adverse events in Swedish hospitals: a retrospective medical record review study. *International journal for quality in health care* 2009;21(4):285-91.
7. Rosenbaum L. Cursed by Knowledge—Building a Culture of Psychological Safety. *The New England Journal of Medicine* 2019;380(8) doi: 10.1056
8. Parand A, Dopson S, Renz A, et al. The role of hospital managers in quality and patient safety: a systematic review. *BMJ open* 2014;4(9):e005055.
9. Salas E, Baker D, King H, et al. On Teams, Organizations, and Safety: Of Course.... *Joint Commission Journal on Quality and Patient Safety* 2006;32(2):112-13.
10. Frankel RM, Tilden VP, Suchman A. Physicians' Trust in One Another. *Jama* 2019;321(14):1345-46.
11. Lawton R, Taylor N, Clay-Williams R, et al. Positive deviance: a different approach to achieving patient safety. *BMJ quality & safety* 2014:bmjqs-2014-003115.
12. Schein EH. *Organizational culture and leadership*: John Wiley & Sons 2010.
13. Bolman LG, Deal TE. *Reframing organizations: Artistry, choice, and leadership*: John Wiley & Sons 2003.
14. Barach P, Small SD. How the NHS can improve safety and learning: by learning free lessons from near misses. *BMJ* 2000;320:1683.
15. Macrae C, Stewart K. Can we import improvements from industry to healthcare? *BMJ* 2019;364:l1039.
16. Hall LH, Johnson J, Watt I, et al. Healthcare staff wellbeing, burnout, and patient safety: A systematic review. *PLoS One* 2016;11(7):e0159015.
17. Barach P, Phelps G. Clinical sensemaking: a systematic approach to reduce the impact of normalised deviance in the medical profession. *Journal of the Royal Society of Medicine* 2013;106(10):387-90.
18. Leggat SG, Bartram T, Casimir G, et al. Nurse perceptions of the quality of patient care: Confirming the importance of empowerment and job satisfaction. *Health Care Management Review* 2010;35(4):355-64.
19. Braithwaite J, Herkes J, Ludlow K, et al. Association between organisational and workplace cultures, and patient outcomes: systematic review. *BMJ open* 2017;7(11):e017708.
20. Karsh B, Holden R, Alper S, et al. A human factors engineering paradigm for patient safety: designing to support the performance of the healthcare professional. *Quality and Safety in Health Care* 2006;15(suppl 1):i59-i65.
21. Wahr JA, Prager RL, Abernathy III J, et al. Patient safety in the cardiac operating room: human factors and teamwork: a scientific statement from the American Heart Association. *Circulation* 2013;128(10):1139-69.
22. Francis R. Report of the Mid Staffordshire NHS Foundation Trust public inquiry: executive summary: The Stationery Office 2013.

- 1
- 2
- 3 23. Wännström I, Peterson U, Åsberg M, et al. Psychometric properties of scales in the General
- 4 Nordic Questionnaire for Psychological and Social Factors at Work (QPSNordic): Confirmatory
- 5 factor analysis and prediction of certified long-term sickness absence. *Scandinavian journal*
- 6 *of psychology* 2009;50(3):231-44.
- 7
- 8 24. Deilkas ET, Hofoss D. Psychometric properties of the Norwegian version of the Safety Attitudes
- 9 Questionnaire (SAQ), Generic version (Short Form 2006). *BMC Health Services Research*
- 10 2008;8:191.
- 11
- 12 25. Huang DT, Clermont G, Kong L, et al. Intensive care unit safety culture and outcomes: a US
- 13 multicenter study. *International Journal for Quality in Health Care* 2010;22(3):151-61.
- 14
- 15 26. Brown A. Organizational culture: The key to effective leadership and organizational development.
- 16 *Leadership & Organization Development Journal* 1992;13(2):3-6.
- 17
- 18 27. Hudson DW, Berenholtz SM, Thomas EJ, et al. A safety culture Primer for the critical care
- 19 Clinician. *Contemporary Critical Care* 2009;7(5):1-11.
- 20
- 21 28. Deilkås E, Hofoss D. Patient safety culture lives in departments and wards: multilevel partitioning
- 22 of variance in patient safety culture. *BMC health services research* 2010;10(1):85.
- 23
- 24 29. Helgeland J KD, Hassani S, Lindman AS. Overlevelse og reinnleggelse ved norske sykehus for 2012.
- 25 Oslo: Nasjonalt kunnskapssenter for helsetjeneren, 2013.
- 26
- 27 30. Hassani S, Lindman AS, Kristoffersen DT, et al. 30-Day Survival Probabilities as a Quality Indicator
- 28 for Norwegian Hospitals: Data Management and Analysis. *PloS one* 2015;10(9):e0136547.
- 29
- 30 31. Kristoffersen DT, Helgeland J, Waage HP, et al. Survival curves to support quality improvement in
- 31 hospitals with excess 30-day mortality after acute myocardial infarction, cerebral stroke and
- 32 hip fracture: a before–after study. *BMJ open* 2015;5(3):e006741.
- 33
- 34 32. Helseidrettoratet. Nasjonale faglige retningslinjer for behandling og rehabilitering ved hjerneslag.
- 35 Oslo: Helseidrettoratet, 2017.
- 36
- 37 33. Hanglberger D. Arbeitszufriedenheit im internationalen Vergleich.
- 38 <http://hdl.handle.net/10419/67925>: FFB-Diskussionspapier, 2011.
- 39
- 40 34. Weigl M, Stab N, Herms I, et al. The associations of supervisor support and work overload with
- 41 burnout and depression: a cross-sectional study in two nursing settings. *Journal of Advanced*
- 42 *Nursing* 2016;72(8):1774-88.
- 43
- 44 35. McHugh MD, Rochman MF, Sloane DM, et al. Better nurse staffing and nurse work environments
- 45 associated with increased survival of in-hospital cardiac arrest patients. *Medical care*
- 46 2016;54(1):74-80.
- 47
- 48 36. Faisy C, Davagnar C, Ladiray D, et al. Nurse workload and inexperienced medical staff members
- 49 are associated with seasonal peaks in severe adverse events in the adult medical intensive
- 50 care unit: A seven-year prospective study. *International Journal of Nursing Studies*
- 51 2016;62:60-70.
- 52
- 53 37. Aiken LH, Clarke SP, Sloane DM, et al. Hospital nurse staffing and patient mortality, nurse
- 54 burnout, and job dissatisfaction. *Jama* 2002;288(16):1987-93.
- 55
- 56 38. McHugh MD, Ma C. Hospital nursing and 30-day readmissions among Medicare patients with
- 57 heart failure, acute myocardial infarction, and pneumonia. *Medical care* 2013;51(1):52.
- 58
- 59 39. Kane RL, Shamliyan TA, Mueller C, et al. The association of registered nurse staffing levels and
- 60 patient outcomes: systematic review and meta-analysis. *Medical care* 2007;45(12):1195-204.
40. Carayon P, Gurses AP. Nursing workload and patient safety—a human factors engineering perspective. In: RG H, ed. *Patient Safety and Quality: An Evidence-Based Handbook for Nurses*. Rockville (MD): Agency for Healthcare Research and Quality (US) 2008.
41. Tvedt C, Sjetne IS, Helgeland J, et al. An observational study: associations between nurse-reported hospital characteristics and estimated 30-day survival probabilities. *BMJ quality & safety* 2014;23(9):757-64. doi: 10.1136/bmjqs-2013-002781
42. West MA, Borrill C, Dawson J, et al. The link between the management of employees and patient mortality in acute hospitals. *International Journal of Human Resource Management* 2002;13(8):1299-310.

- 1  
2  
3 43. Edmondson A, Moingeon B. Learning, trust and organizational change. *Organizational learning and the learning organization* 1999;157-75.
- 4  
5 44. Gutberg J, Berta W. Understanding middle managers' influence in implementing patient safety culture. *BMC health services research* 2017;17(1):582.
- 6  
7 45. West M, Dawson J. Employee engagement and NHS performance: King's Fund London 2012.
- 8  
9 46. Veronesi G, Kirkpatrick I, Altanlar A. Are Public Sector Managers a "Bureaucratic Burden"? The Case of English Public Hospitals. *Journal of Public Administration Research and Theory* 2018;29(2):193-209. doi: 10.1093/jopart/muy072
- 10  
11 47. Conway J. Getting boards on board: engaging governing boards in quality and safety. *The Joint Commission Journal on Quality and Patient Safety* 2008;34(4):214-20.
- 12  
13 48. Amalberti R, Auroy Y, Berwick D, et al. Five system barriers to achieving ultrasafe health care. *Annals of internal medicine* 2005;142(9):756-64.
- 14  
15 49. Deilkas E, Hofoss D. Patient safety culture lives in departments and wards: multilevel partitioning of variance in patient safety culture. *BMC Health Services Research* 2010;10:85.
- 16  
17 50. Borzecki AM, Christiansen CL, Chew P, et al. Comparison of In-Hospital Versus 30-Day Mortality Assessments for Selected Medical Conditions. *Medical Care* 2010;48(12):1117-21. doi: 10.1097/MLR.0b013e3181ef9d53
- 18  
19 51. Krumholz HM, Wang Y, Mattera JA, et al. An administrative claims model suitable for profiling hospital performance based on 30-day mortality rates among patients with an acute myocardial infarction. *Circulation* 2006;113(13):1683-92.
- 20  
21 52. OECD. Health at a glance 2013: OECD indicators: OECD 2013.
- 22  
23 53. Cecil E, Wilkinson S, Bottle A, et al. National hospital mortality surveillance system: a descriptive analysis. *BMJ quality & safety* 2018;bmjqs-2018-008364.
- 24  
25 54. Tourangeau AE, Cranley LA, Jeffs L. Impact of nursing on hospital patient mortality: a focused review and related policy implications. *Quality and Safety in Health Care* 2006;15(1):4-8. doi: 10.1136/qshc.2005.014514
- 26  
27 55. Taylor N, Clay-Williams R, Hogden E, et al. High performing hospitals: a qualitative systematic review of associated factors and practical strategies for improvement. *BMC health services research* 2015;15(1):244.
- 28  
29 56. Ioannidis JP, Munafò MR, Fusar-Poli P, et al. Publication and other reporting biases in cognitive sciences: detection, prevalence, and prevention. *Trends in cognitive sciences* 2014;18(5):235-41.
- 30  
31 57. Shanafelt TD, Mungo M, Schmitgen J, et al. Longitudinal study evaluating the association between physician burnout and changes in professional work effort. *Mayo Clinic Proceedings* 2016;91(4):422-31.
- 32  
33 58. Bognár A, Barach P, Johnson JK, et al. Errors and the burden of errors: attitudes, perceptions, and the culture of safety in pediatric cardiac surgical teams. *The Annals of Thoracic Surgery* 2008;85(4):1374-81.
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## Footnotes

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3 **Contributors:** KB developed the idea for the study, interpreted results, drafted and revised  
4 manuscript; MVS conducted analysis, drafted the results, contributed to manuscript  
5 revisions; DH contributed to result interpretation and manuscript drafting and revisions;  
6  
7 TMH contributed to obtaining patient data and manuscript revisions; PB contributed to  
8 manuscript development and revisions; OT contributed to interpretation of results,  
9 manuscript development and revisions.  
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14  
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17  
18

19 **Competing interests:** None declared  
20  
21

22 **Ethical approval:** The study was approved by the Medical and Health Research Ethics  
23 Committee (REC) in South Eastern Norway with waiver of informed consent, since all data  
24 used in the study were anonymous. (Case number 2011/2345 D)  
25  
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28 **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   |
|---------------------------|----------|--|----------|---|
| <b>Title and abstract</b> | 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        |   |
| <b>Introduction</b>       |          |  |          |   |
| 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.              |
| <b>Methods</b>            |          |  |          |   |
| 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) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up<br><i>Case-control study</i> —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<br><i>Cross-sectional study</i> —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.<br><br>* All adult patients admitted to hospital with AMI, stroke (>18 |

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|                              |    |  |       | 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/<br>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 |

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2 during the previous two years.  
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4 Diagnosis-specific outcomes  
5 were aggregated over the three  
6 years (2010-2012) to ensure  
7 there was adequate statistical  
8 power.  
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| 13 Study size | 10 | 14 Explain how the study size was arrived at | 15 | 16 5,7 | 17 All adult patients with the<br>18 indicated diagnoses were<br>19 included.<br>20 All staff responding to the<br>21 survey and stating their<br>22 profession as nurse, physician or<br>23 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     | $Relative\ mortality\ rate_{unit} = \frac{Mean\ mortality\ rate_{patient\ group}}{Mean\ mortality\ rate_{unit}}$                       |
| 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) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed<br><i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed<br><i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy | NA    |  |
|                        |     | (e) Describe any sensitivity analyses   | NA    |  |
| <b>Results</b>         |     |   |       |  |
| 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) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)  |       |  |
| Outcome data           | 15* | <i>Cohort study</i> —Report numbers of outcome events or summary measures over time<br><i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure<br><i>Cross-sectional study</i> —Report numbers of outcome events or summary measures                         | 17,18 | See Tables 4 and 5   |

|   |              |    |  |   |
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| 2 | 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  |
| 3 |              |    |  | See Table 5 Adjusted for diagnosis and the annual number of treatment on each ward. |
| 4 |              |    |  |   |
| 5 |              |    |  |   |
| 6 |              |    | (b) Report category boundaries when continuous variables were categorized  | NA  |
| 7 |              |    |  |   |
| 8 |              |    | (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period   | NA  |
| 9 |              |    |  |   |

Continued on next page

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|                          |    |  |    |   |
|--------------------------|----|--|----|---|
| Other analyses           | 17 | Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses   | NA |   |
| <b>Discussion</b>        |    |  |    |   |
| 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 |   |
| <b>Other information</b> |    |  |    |   |
| 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](http://www.strobe-statement.org).

# BMJ Open

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

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|---------------------------------|---|
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| <b>Primary Subject Heading</b>: | Health services research  |
| Secondary Subject Heading:      | Health policy   |
| Keywords:                       | Patient safety, Work environment, Patient outcome, Safety climate, Staff engagement, Safety culture   |
|                                 |   |

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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

## 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<sub>95</sub> 0.009-0.028)) and middle manager engagement (Beta 0.024 (CI<sub>95</sub> 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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3 and death risks for patients due to organizational characteristics.  
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9 **Strengths and limitations of this study**

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11 • This is the first study, to our knowledge, combining profession-specific work place  
12 survey data with patient mortality data correlated with the hospital ward levels.  
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14 • This study is strengthened by the use of ward specific level data as hospital data can  
15 mask inter-ward differences.  
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17 • A case-mix adjustment model was developed for the comparison between hospital  
18 wards but not for the disease severity, thus it is hard to distinguish between patients  
19 who might die from the severity of their illness and less severe cases, for whom the  
20 lack of high-quality care ultimately may have reduced their chances of survival.  
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22 • Although the study included hospitals providing health care services to more than  
23 half of the Norwegian population, the number of wards is too small to allow the use  
24 of complex multi-variate analyses.  
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26 • These data suggest a unique and important role for staff satisfaction and  
27 psychological safety.  
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Hospitals are complex social-cultural organizations defined by their complexity of operations, uncertainty and interdependency.<sup>1</sup> A strong linkage between the organization of care and patient outcomes has been found in several studies.<sup>2,3</sup> 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.<sup>4,5</sup> 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.<sup>6</sup> High-reliability organizational theory posits that organizational features including psychological safety<sup>7</sup>, leadership involvement,<sup>8</sup> team based care,<sup>9</sup> trusting support,<sup>10</sup> and a relentless culture of quality measurement are needed to sustain reliable improvements in care.<sup>11</sup>

The impact of organizational culture on quality, reporting of data, and safety in non-medical organizations is well documented.<sup>12-15</sup> 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.<sup>16,17</sup> Leggat et al<sup>18</sup> have consistently demonstrated that a reported positive relationship between high-performance workplaces and organizational outcome also applies to patient outcomes in healthcare organizations.<sup>19</sup>

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.<sup>20,21</sup>

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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3 for all patients admitted with AMI, stroke and hip-fracture in 20 hospitals in Norway.  
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6 Staff in all hospitals administered by the HSO in Norway were invited to participate in  
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8 a web-based work environment questionnaire based on the General Nordic Questionnaire  
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10 for Psychological and Social Factors at Work (QPSnordic), that was adapted for healthcare.<sup>22</sup>  
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12 More than 75,000 are employed in HSO, and all staff employed for more than three months  
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14 in the hospital were eligible for participation. Nearly 50,000 questionnaires were distributed  
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16 in each of the studied years (2010, 2011, 2012). The data was collected electronically. To  
17  
18 secure anonymity of the participants, only data from wards with more than five responders  
19  
20 were processed.

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22 The survey was designed to assess the local hospital work environment and  
23  
24 distinguish the differences between hospital wards. The questionnaire has 57 items,  
25  
26 measuring the work environment along 19 dimensions. (Table 1) The survey was  
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28 supplemented with questions addressing the factor patient safety culture as an important  
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30 aspect of the healthcare work environment. The safety culture questions were adapted from  
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32 the Norwegian validated version of the Safety Attitude Questionnaire (SAQ).<sup>23</sup> The response  
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34 alternatives are presented on a 5-point Likert scale (for some items “Strongly disagree”,  
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36 “Disagree”, “Neither disagree nor agree”, “Agree”, “Strongly agree” or, where appropriate,  
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38 “Never/very seldom”, “Seldom”, “Sometimes”, “Quite often”, “Very often/always”). The  
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40 categories were assigned the values 0-25-50-75-100, assuming an equal distance between  
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42 scores.<sup>24</sup> The value zero reflects the highest burden/least favorable conditions and the score  
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44 100 means the most positive rating (i.e., is coping/satisfied). The coding of negatively  
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46 worded items was reversed to ensure that the higher code values always indicate a more  
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48 positive response. The score on each dimension was calculated as the mean of the score on  
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50 each item included in the dimension. For each of the 56 wards in the study, the mean work  
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52 environment scores were calculated. The individual responses with missing data were  
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54 excluded from the analysis. A report with the mean average scores on each item and factor  
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56 in the survey for each ward was produced and made public. Nurses in HSO are assigned to  
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58 work on one designated hospital ward and the nurse responses were attributed to the  
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60 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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3 We defined the work system to include the persons, organization, tools and  
4 technologies, tasks and their work environment.<sup>25</sup> Work environment is the *physical and*  
5 *organizational culture under which healthcare professionals perform their tasks.* Patient  
6 safety culture is a component of organizational culture and has been shown to be associated  
7 with patient outcomes.<sup>26</sup>  
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13 The definitions and measurements of culture vary. For this study, we defined  
14 organizational culture as *the behaviors that emerge based on shared values, beliefs,*  
15 *assumptions, and norms.*<sup>12 13 27</sup> Previous research has demonstrated more variation in  
16 culture assessments between different clinical wards within the same hospital than between  
17 the hospitals.<sup>28</sup> We used the ward level as our level of outcomes, as previous studies have  
18 shown that data aggregated at the hospital level may mask the hospital unit's differences.<sup>29</sup>  
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24 The Norwegian Institute of Public Health (FHI) reports annually hospital survival  
25 probabilities for patients diagnosed with AMI, stroke, hip-fracture, and hospital-wide  
26 survival rate quality indicators for Norwegian hospitals.<sup>30</sup> The mortality rates are estimated  
27 based on all-cause deaths, tracking patients with their unique Norwegian Personal  
28 Identification Number. The mortality rates were risk-adjusted for age, gender, and the  
29 Charlson Comorbidity index scores based on the patients' hospital admissions during the  
30 three years prior to their hospital admission, type of stroke (cerebral hemorrhage/cerebral  
31 infarction), and the total number of hospitalizations during the previous two years. In the  
32 event where a patient admission involved more than one hospital, the patient mortality  
33 probability was split between the two hospitals according to the time the patient spent at  
34 each hospital in order to reduce potential bias. The management and analysis methods of  
35 the Norwegian survival data are described in great detail by Hassani et al.<sup>31 32</sup> This study used  
36 risk-adjusted patient data from the FHI for patients admitted to hospitals with AMI, stroke  
37 and hip-fracture.  
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51 The 7-day mortality rate was chosen to study the possible associations between the  
52 work environment and mortality for high-risk patients in hospital. A more extended  
53 observation period (such as 30-day), might confound the findings and include mortality  
54 unrelated to hospital characteristics, such as variations in post discharge care at local nursing  
55 homes and home healthcare services. Importantly, the ward mortality rates were calculated  
56 for the patients with the included diagnosis only, and not combined with the mortality of  
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3 patients with other diagnoses, even if they were cared for on the same wards.  
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6 The relative mortality rates were defined as the deviation of the hospital unit's  
7 mortality rates from the mean mortality rates for the specific diagnosis groups, and then  
8 they were divided by the mean mortality rates for the specific diagnosis group. This relative  
9 mortality rate can be compared across all three diagnostic groups and allows for pooling of  
10 all hospital ward data. The formula we used is as follows:  
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$$15 \text{Relative mortality rate}_{unit} = \frac{\text{Mean mortality rate}_{patient\ group} - \text{Mortality rate}_{unit}}{\text{Mean mortality rate}_{patient\ group}}$$

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22 The diagnosis-specific outcomes were aggregated over a three-year period (2010, 2011,  
23 2012) to ensure adequate statistical power.  
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### 26 **Selection of Hospitals**

27 All twenty public hospitals in HSO providing acute care were included, with 17  
28 hospitals that treated all three patient diagnoses included in this study, while three hospitals  
29 treated only one or two of the three included patient sub-groups, for a total of 56 wards.  
30 The hospitals varied in size and geographic catchment areas, but had comparable  
31 organizational structures and policies, with specially designated patient wards caring for the  
32 three subgroups of patients. Patients admitted with a cerebral stroke were treated in stroke  
33 units according to national guidelines,<sup>33</sup> whereas patients with a hip-fracture were  
34 postoperatively cared for on orthopedic wards. Patients with AMI were subjected to a pre-  
35 hospital triage such that patients with suspected STEMI infarction were transported directly  
36 to PCI centers, whereas, patients with non-STEMI infarction were admitted to cardiac units  
37 at each of the respective HSO hospitals.  
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49 The ward level data on the work environment scores was made available from HSO  
50 and the patient mortality rates were made available from the FHI for the three-year period  
51 (2010, 2011, 2012) and were combined using ward names as an identifier.  
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### 55 **Statistical Analyses**

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57 The descriptive data on number of patients treated and survey responses were given  
58 as medians and the range due to the non-normal distribution. Normality was tested by the  
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3 nonparametric Kolmogorov–Smirnov test.<sup>34</sup> The associations between the profession-  
4 specific work environments and adjusted patient mortality rates at a specific ward level were  
5 analyzed using a linear regression model that was adjusted for diagnosis and the annual  
6 number of treatments.  
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11 The effects of the different work environmental factors were analyzed and reported  
12 separately, as the limited number of wards studied (n=56) prohibited including all  
13 explanatory variables in one single multi-variable predictive model. A backward conditional  
14 regression analysis was performed by including all the significant work environmental factors  
15 from the initial separate analysis (Nurses: Patient centered, Respect, Motivation,  
16 Engagement, Commitment, Role expectations, Workload, Autonomy, Role conflicts, Sick  
17 leave, Leadership, Patient safety climate; Physicians: None; Managers: Quality, Motivation,  
18 Engagement, Commitment, Personal development, Empowerment, Social climate,  
19 Workload, Role conflicts). The level for the removal of variables was set to  $P>0.05$ . Both the  
20 variables available for the backward regression and the final models were evaluated against  
21 our hypothesis and prior research and was found to be plausible. In addition alternative  
22 approaches as manually built models did not identify better performing models. The work  
23 environment effects for physicians, nurses and middle managers were analyzed separately  
24 to assess how patient mortality was associated with the work environment for the three  
25 professions. The statistical significance level was set at 0.05, and the 95% confidence  
26 intervals are presented below. All outcomes and statistical analyses were carried out using  
27 the IBM SPSS statistical package Version 21.  
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### 42 **Patient and Public Involvement**

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45 The study protocol and results of this study have been presented to the Regional  
46 Patient Representative Committee who supported the study design and its relevance.  
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## 50 **RESULTS**

### 51 *Safety Culture Survey*

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54 The web-based work environment and safety culture data were collected from 2010  
55 to 2012. Nearly 50,000 questionnaires were distributed annually. The response rates for  
56 2010, 2011, and 2012, were 72%, 77%, and 75%, respectively. The background information  
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3 such as gender, age and profession was stated voluntarily. Seventy-eight percent of the  
4 respondents defined their occupation. In total, 5,602 responses from nurses, 2,195 from  
5 physicians, and 1,036 from middle managers were included in the analysis. (Table 2)  
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9 All emergency patients admitted with AMI, stroke, and hip-fracture were included.  
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11 Diagnosis-specific mortality rates were calculated for all adult patients (age>18) with the  
12 corresponding diagnoses as follows: 17,734 patients admitted with first time acute  
13 myocardial infarction (AMI) (ICD-10 I21.x), 14,442 cerebral stroke patients (ICD-10  
14 I61.63.64), and 13,850 patients admitted over the age of 65 with a hip-fracture (ICD-10  
15 S72.0-2). The average length of hospital stay for the patients included in the study was 8.1  
16 days. The 7-day mortality rates varied from 2.8% - 7.7%. The mean Charlson Comorbidity  
17 Index score was 1.5. (Table 3)  
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24 The median number of treatments for the 56 wards that participated in this study,  
25 (patients within the diagnosis codes included) were 214, with a range varying from 36 to  
26 1242. The median number of work environment survey responses per ward included in the  
27 analysis was 87 (range 26-296) for nurses, 32 (range 5-157) for physicians, and 15 (range 5-  
28 47) for managers.  
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34 Hospital staff rated their work environment positively on the 0-100 scale (100  
35 indicating the most favorable condition): the mean scores for nurses, physicians, and middle  
36 managers were 70.5, 67.2 and 76.3, respectively. The middle managers reported higher  
37 scores than physicians and nurses on all but three of the 19 organizational factors, while the  
38 nurses scored lower than managers and physicians on nine of the 19 factors. The mean  
39 scores and standard deviation for each factor are presented by profession in Table 4.  
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46 Table 5 shows that several organizational factors were significantly associated with  
47 increased patient mortality probability. The backward regression model demonstrated that a  
48 higher perceived workload by nurses was significantly associated with increased patient  
49 mortality: beta = 0.019 (CI<sub>95</sub> 0.009, 0.028). Nurses: Workload  $P<0.001$ , Respect  $P=0.002$ ,  
50 Patient safety culture  $P=0.003$ , Role conflicts  $P=0.004$ , Patient centered  $P=0.005$ ,  
51 Engagement  $P=0.005$ , Autonomy  $P=0.007$ , Sick leave  $P=0.007$ , Commitment  $P=0.009$ ,  
52 Motivation  $P=0.022$ , Role expectation  $P=0.031$ , Leadership  $P=0.045$ . For middle managers,  
53 engagement was significantly associated with seven-day mortality: beta= 0.024 (CI<sub>95</sub> 0.010,  
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3 0.037). Middle managers: Engagement  $P=0.001$ , Personal development  $P=0.001$ , Motivation  
4  $P=0.002$ , Social climate  $P=0.005$ , Workload  $P=0.006$ , Commitment  $P=0.010$ , Role conflict  
5  $P=0.010$ . No significant association was found between the physician reported work  
6 environment scores and patient mortality.  
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## 10 11 **DISCUSSION**

12  
13 We found a strong correlation between organizational work environment and 7-day  
14 patient mortality. This study extends findings in the literature demonstrating that the work  
15 environment at the 20 South-Eastern Norway Health Region Hospitals were significantly  
16 related to their reported 7-day mortality for patients admitted with AMI, stroke and hip-  
17 fractures. We observed a significant increase in patient mortality in hospital units where  
18 nurses reported excessive workload and middle managers reported a lack of professional  
19 and organizational engagement. No such associations were found between physician  
20 reported work environment and patient mortality.  
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28 Hospital staff scored their work environment positive (over 70) on a 0-100 scale (100  
29 being the most favorable), consistent with the general satisfaction reported by Norwegian  
30 employees who report higher job satisfaction than employees in other countries.<sup>35</sup> However,  
31 there were profession-specific differences that may have contributed to the observed  
32 variation in the patient outcomes across the 56 hospital wards. Overall, the middle  
33 managers scored higher than physicians and nurses, and nurses scored lowest on more  
34 organizational factors than managers and physicians.  
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40 Whereas nurses typically worked on one hospital ward, physicians and middle  
41 managers usually worked and saw patients on several clinical units, and the assessment of  
42 their work environment should be interpreted accordingly. We stress that it is not the  
43 physician or manager perceptions of the patient ward that are being measured, but the  
44 explicit perceptions about their work environments where physicians and middle managers  
45 work (entire clinical departments) supporting these patient wards.  
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51 Twelve of the 19 organizational environmental factors scored by nurses were  
52 significantly associated with 7-day patient mortality suggesting that the reported nursing  
53 workload may be underappreciated as an important driver for nurse satisfaction.<sup>36</sup> The  
54 workload was the most prominent and derived from survey items such as *“Is the physical*  
55 *load of your work too heavy?”*, *“Is your workload challenging?”*, and *“Do you perform work*  
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3 *tasks for which you need more training?"* These survey items describe the nurses'  
4 perceptions about their degree of control over the daily assigned tasks. Our findings  
5 reinforce previous studies suggesting that reducing the nurse workload may increase nurse  
6 satisfaction and decrease patient mortality.<sup>37-43</sup>  
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10 Managers play a critical role, as frontline leaders, in nurturing a psychologically safe  
11 culture by setting the norms for speaking up, and promoting shared *meanings* and *practices*.  
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14<sup>44-46</sup> The middle managerial roles, situated between the senior hospital management and  
15 front-line workers, offers a unique vantage point to assess the maturity of the culture as  
16 they implement and oversee strategies and work policies. At the same time, middle  
17 managers are responsible for bringing staff concerns and needs back to senior management  
18 for consideration and action. Managers can contribute to organizational change by  
19 capitalizing on this position,<sup>47</sup> as management involvement and engagement have been  
20 documented as a positive influence on care delivery systems.<sup>8 48 49</sup> At the same time, top-  
21 management and hospital boards engagement in patient safety initiatives can enhance the  
22 middle managers' support for a safety culture that can affect patient mortality.<sup>50</sup>  
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30 As noted above, we did not find a correlation between patient mortality and  
31 physicians' perception of their work environment. The interpretation may not necessarily  
32 mean that physician work environment is unrelated to patient outcomes. We think this may  
33 be the result of physicians' sense of autonomy<sup>51</sup> and their responsibility covering patients  
34 on multiple departments and service lines simultaneously and this might affect their  
35 responses. Nurses define their work environment in more straightforward terms. Their work  
36 is generally restricted to one patient ward, and they will have this ward in mind when  
37 responding to work surveys. Nurses report to, and are assigned tasks by, a supervisor on a  
38 daily basis; the same cannot be said for physicians who have much autonomy about when  
39 and where their care activities take place. This structural difference can lead to a physician-  
40 as-manager philosophy and a nurse-as-employee philosophy in many healthcare  
41 organizations and contribute to variation seen when assessing the impact of clinical  
42 interventions on different providers. Previous research has identified differences in culture  
43 and work styles within hospitals, and much of this variance was found to be located at the  
44 ward and microsystem levels.<sup>29</sup> The responses from physicians working on several hospital  
45 wards may attenuate these inter-ward differences, as their answers are based on their  
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3 "average experiences" from several clinical environments. This might explain the physician  
4 lack of significant association by hospital ward.  
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7 We focused on mortality rates as our dependent variable as mortality is well-defined,  
8 easily measured, considered useful for estimating the effect of hospital care,<sup>32,52</sup> and "it  
9 matters a lot to patients".<sup>53</sup> Patient mortality rates in Norwegian hospitals and the variation  
10 between hospitals is lower than in other OECD countries.<sup>54</sup> However, some Norwegian  
11 hospitals have mortality rates significantly higher than the national average. Although a  
12 significant part of the variation observed in hospital mortality can be explained by  
13 differences in the case-mix and to random variation, it has been suggested that as much as  
14 30-60% of this variation can be attributed to differences in the practices and quality of  
15 patient care.<sup>55</sup> Some hospitals have structures and processes that minimize avoidable  
16 patient deaths better than others.<sup>56</sup> Studying these high performing hospitals can be  
17 valuable as they provide deeper insights about which factors are most important for  
18 organizational success and reliability.<sup>57</sup>  
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29 Our study have several limitations. First, the lack of available, detailed data on the  
30 severity of the patient's illnesses at the time of their hospital admission. Our data was case-  
31 mix adjusted for age, gender, comorbidity, and the number of previous hospitalizations two  
32 years before the present admission, but not, for the disease severity of each diagnosis.  
33 Accordingly, it is challenging to distinguish between patients who may have died from the  
34 severity of their illness and less severe cases, for whom the lack of high-quality care  
35 ultimately may have reduced their chances of survival.  
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41 Second, the study design did not allow the linking of nurse, physician and middle  
42 manager' care culture evaluation to the survival of the individual patients under their care.  
43 That is, we were only able to relate the average staff evaluations to the average patient  
44 mortality for each hospital unit. However, we addressed this by using a diagnosis-specific  
45 mortality rate that allowed us to link the work environmental perceptions to the hospital  
46 wards where the patients were treated for their primary diagnosis. This afforded us the  
47 opportunity to dig deeper into our study dataset to examine the robust links between the  
48 work environment and patient outcomes.  
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56 Third, the previous safety culture literature may also be subject to publication bias.<sup>58</sup>  
57 Few randomized controlled studies exist to demonstrate the causal relationships between  
58 organizational culture and clinical outcomes. Thus, our findings are important and have  
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3 practical implications. Also, the culture evaluation surveys are susceptible to response bias  
4 at both the individual and ward respondent levels, but our response rate of 70-75%  
5 compares favorably with those of similar studies.<sup>59</sup> We believe that one should consider  
6 other methodologies (qualitative/ethnographic) as useful tools for a deeper exploration of  
7 the informal work cultures of the high and low performing wards in our study and how they  
8 might affect the success of these hospital wards.<sup>60 61</sup>  
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14 Because all the analyses are conducted at the hospital ward level, our sample of 56  
15 wards is relatively small to detect statistical significance, making the size and direction of the  
16 correlation coefficients more informative in this context. Although the included hospitals  
17 represent nearly half of all Norwegian hospital beds, Norway is a small country and the  
18 limited number of units prevents complex multi-variate analyses. This could mean that the  
19 variables that could have explained the mortality variation could not be controlled for. We  
20 cannot rule out the possibility that the associations we observed may therefore be non-  
21 causal.  
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29 Finally, our study reflects the context and distinct constraints of the Norwegian  
30 healthcare delivery systems, which may be different from other healthcare systems.  
31 Norwegian employees generally perceive their work environment as more positive than staff  
32 in other countries,<sup>35</sup> and patient survival is relatively high.<sup>54</sup> The study, however, probably  
33 carries relevance for the population as a whole, and has strong external generalizability to  
34 other countries, because it stems from a large and diverse sample of hospitals.  
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## 40 **CONCLUSIONS**

41 Patients fare better in hospitals in which employees declare a supportive and  
42 nurturing place to work. Our data suggest that if nurses feel supported, and managers feel  
43 engaged in their work, these organizational features of care delivery systems can affect  
44 patient hospital mortality. A deeper understanding of these cultural and organizational  
45 influences, and how they can increase the performance toward achieving the overall  
46 organization goals, is critical to developing meaningful interventions to improve patient  
47 outcomes. Assessment of these organizational and cultural metrics might be quite useful in  
48 monitoring the safety of hospitals and supporting hospital quality improvement efforts.  
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Table 1. Work Environment Factors and Survey Items

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

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

|   | <b>Acute Myocardial Infarction (first time)</b> | <b>Stroke</b> | <b>Hip Fracture (&gt;65 years)</b> |
|---|---|---------------|------------------------------------|
| <b>Number of Patients</b>   | 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%)                      |
| <b>Age, mean</b>  | 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%)                      |
| <b>Number of previous hospitalization during last two years, mean</b> | 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%)                       |
| <b>Charlson comorbidity index, mean</b>                               | 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<br>(24.2%) |
| 3+ points | 4165 (23.5%) | 2808 (18.4%) | 3616<br>(25.1%) |

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

| Measures               | Nurse |    | Physician |    | Manager |    |
|------------------------|-------|----|-----------|----|---------|----|
|                        | 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  |

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<br>(-0.006, 0.022) | 0.245   | 0.007<br>(-0.003, 0.019)  | 0.204   | 0.009<br>(-0.003, 0.021) | 0.139   |
| Improvement  | 0.011<br>(-0.005, 0.027) | 0.189   | 0.008<br>(-0.007, 0.023)  | 0.305   | 0.012<br>(-0.004, 0.027) | 0.130   |
| Quality  | 0.017<br>(-0.001, 0.034) | 0.057   | 0.004<br>(-0.008, 0.016)  | 0.481   | 0.014<br>(0.001, 0.027)  | 0.032   |
| Patient centered   | 0.023<br>(0.007, 0.039)  | 0.005   | 0.001<br>(-0.015, 0.017)  | 0.882   | 0.014<br>(-0.001, 0.030) | 0.075   |
| Respect  | 0.035<br>(0.013, 0.057)  | 0.002   | 0.005<br>(-0.013, 0.023)  | 0.577   | 0.015<br>(-0.002, 0.031) | 0.077   |
| Motivation   | 0.024<br>(0.004, 0.044)  | 0.022   | -0.004<br>(-0.019, 0.010) | 0.53    | 0.028<br>(0.010, 0.045)  | 0.002   |
| Engagement   | 0.021<br>(0.007, 0.036)  | 0.005   | -0.006<br>(-0.019, 0.008) | 0.407   | 0.024<br>(0.010, 0.037)  | 0.001   |
| Commitment   | 0.015<br>(0.004, 0.026)  | 0.009   | -0.004<br>(-0.017, 0.009) | 0.537   | 0.018<br>(0.004, 0.031)  | 0.010   |
| Personal development                                     | 0.012<br>(-0.002, 0.025) | 0.094   | -0.002<br>(-0.017, 0.014) | 0.826   | 0.018<br>(0.007, 0.029)  | 0.001   |
| Empowerment  | 0.010<br>(-0.006, 0.025) | 0.231   | 0.000<br>(-0.012, 0.011)  | 0.948   | 0.011<br>(0.001, 0.022)  | 0.037   |
| Role expectations  | 0.039<br>(0.004, 0.074)  | 0.031   | 0.003<br>(-0.014, 0.019)  | 0.750   | 0.011<br>(-0.008, 0.031) | 0.236   |
| Social climate   | 0.012<br>(-0.006, 0.030) | 0.194   | -0.008<br>(-0.020, 0.004) | 0.211   | 0.019<br>(0.006, 0.031)  | 0.005   |
| Conflicts and bullying                                   | 0.003<br>(-0.017, 0.023) | 0.765   | -0.009<br>(-0.021, 0.002) | 0.111   | 0.010<br>(-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,<br>0.028) |       | (-0.016,<br>0.012) |       | (0.005,<br>0.031)  |       |
| Autonomy                  | 0.021             | 0.007 | -0.005             | 0.496 | 0.009              | 0.106 |
|                           | (0.006,<br>0.035) |       | (-0.019,<br>0.009) |       | (-0.002,<br>0.021) |       |
| Role conflicts            | 0.027             | 0.004 | 0.002              | 0.786 | 0.015              | 0.010 |
|                           | (0.009,<br>0.046) |       | (-0.012,<br>0.016) |       | (0.004,<br>0.026)  |       |
| Sick leave                | 0.021             | 0.007 | -0.003             | 0.656 | 0.009              | 0.125 |
|                           | (0.006,<br>0.036) |       | (-0.017,<br>0.010) |       | (-0.003,<br>0.021) |       |
| Leadership                | 0.011             | 0.045 | 0.002              | 0.726 | 0.008              | 0.067 |
|                           | (0.000,<br>0.022) |       | (-0.010,<br>0.014) |       | (-0.001,<br>0.017) |       |
| Patient safety<br>climate | 0.017             | 0.003 | 0.005              | 0.449 | 0.003              | 0.717 |
|                           | (0.006,<br>0.029) |       | (-0.009,<br>0.020) |       | (-0.013,<br>0.018) |       |

\* 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.

## References

1. Snowden DJ, Boone ME. A Leaders Framework for Decision Making-Wise executive tailor their approach to fit the complexity of the circumstances they face. *Harvard Business Review* 2007;85(11):68.
2. Mitchell PH, Shortell SM. Adverse Outcomes and Variations in Organization of Care Delivery. *Medical Care* 1997;35(11):NS19-NS32.
3. Kohn LT, Corrigan JM, Donaldson M. To Err is Human: Building a Safer Health System. Washington, D.C.: National Academy Press 1999.
4. Craig P, Dieppe P, Macintyre S, et al. Developing and evaluating complex interventions: the new Medical Research Council guidance. *BMJ (Clinical research ed)* 2008;337:a1655. doi: 10.1136/bmj.a1655
5. Cassin BR, Barach PR. Making sense of root cause analysis investigations of surgery-related adverse events. *Surgical Clinics* 2012;92(1):101-15.
6. Soop M, Fryksmark U, Köster M, et al. The incidence of adverse events in Swedish hospitals: a retrospective medical record review study. *International journal for quality in health care* 2009;21(4):285-91.
7. Rosenbaum L. Cursed by Knowledge—Building a Culture of Psychological Safety. *The New England Journal of Medicine* 2019;380(8) doi: 10.1056
8. Parand A, Dopson S, Renz A, et al. The role of hospital managers in quality and patient safety: a systematic review. *BMJ open* 2014;4(9):e005055.
9. Salas E, Baker D, King H, et al. On Teams, Organizations, and Safety: Of Course.... *Joint Commission Journal on Quality and Patient Safety* 2006;32(2):112-13.
10. Frankel RM, Tilden VP, Suchman A. Physicians' Trust in One Another. *Jama* 2019;321(14):1345-46.
11. Lawton R, Taylor N, Clay-Williams R, et al. Positive deviance: a different approach to achieving patient safety. *BMJ quality & safety* 2014:bmjqs-2014-003115.
12. Schein EH. Organizational culture and leadership: John Wiley & Sons 2010.
13. Bolman LG, Deal TE. Reframing organizations: Artistry, choice, and leadership: John Wiley & Sons 2003.
14. Barach P, Small SD. How the NHS can improve safety and learning: by learning free lessons from near misses. *BMJ* 2000;320:1683.
15. Macrae C, Stewart K. Can we import improvements from industry to healthcare? *BMJ* 2019;364:l1039.
16. Hall LH, Johnson J, Watt I, et al. Healthcare staff wellbeing, burnout, and patient safety: A systematic review. *PLoS One* 2016;11(7):e0159015.
17. Barach P, Phelps G. Clinical sensemaking: a systematic approach to reduce the impact of normalised deviance in the medical profession. *Journal of the Royal Society of Medicine* 2013;106(10):387-90.
18. Leggat SG, Bartram T, Casimir G, et al. Nurse perceptions of the quality of patient care: Confirming the importance of empowerment and job satisfaction. *Health Care Management Review* 2010;35(4):355-64.
19. Braithwaite J, Herkes J, Ludlow K, et al. Association between organisational and workplace cultures, and patient outcomes: systematic review. *BMJ open* 2017;7(11):e017708.

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20. Karsh B, Holden R, Alper S, et al. A human factors engineering paradigm for patient safety: designing to support the performance of the healthcare professional. *Quality and Safety in Health Care* 2006;15(suppl 1):i59-i65.
21. Wahr JA, Prager RL, Abernathy III J, et al. Patient safety in the cardiac operating room: human factors and teamwork: a scientific statement from the American Heart Association. *Circulation* 2013;128(10):1139-69.
22. Wännström I, Peterson U, Åsberg M, et al. Psychometric properties of scales in the General Nordic Questionnaire for Psychological and Social Factors at Work (QPSNordic): Confirmatory factor analysis and prediction of certified long-term sickness absence. *Scandinavian journal of psychology* 2009;50(3):231-44.
23. Deilkas ET, Hofoss D. Psychometric properties of the Norwegian version of the Safety Attitudes Questionnaire (SAQ), Generic version (Short Form 2006). *BMC Health Services Research* 2008;8:191.
24. Huang DT, Clermont G, Kong L, et al. Intensive care unit safety culture and outcomes: a US multicenter study. *International Journal for Quality in Health Care* 2010;22(3):151-61.
25. Carayon P, Hundt AS, Karsh B, et al. Work system design for patient safety: the SEIPS model. *Quality and Safety in Health Care* 2006;15(suppl 1):i50-i58.
26. Palmieri PA, Peterson LT, Pesta BJ, et al. Safety culture as a contemporary healthcare construct: theoretical review, research assessment, and translation to human resource management. Strategic human resource management in health care: Emerald Group Publishing Limited 2010:97-133.
27. Brown A. Organizational culture: The key to effective leadership and organizational development. *Leadership & Organization Development Journal* 1992;13(2):3-6.
28. Hudson DW, Berenholtz SM, Thomas EJ, et al. A safety culture Primer for the critical care Clinician. *Contemporary Critical Care* 2009;7(5):1-11.
29. Deilkås E, Hofoss D. Patient safety culture lives in departments and wards: multilevel partitioning of variance in patient safety culture. *BMC health services research* 2010;10(1):85.
30. Helgeland J KD, Hassani S, Lindman AS. Overlevelse og reinnleggelse ved norske sykehus for 2012. Oslo: Nasjonalt kunnskapssenter for helsetjenesten, 2013.
31. Hassani S, Lindman AS, Kristoffersen DT, et al. 30-Day Survival Probabilities as a Quality Indicator for Norwegian Hospitals: Data Management and Analysis. *PloS one* 2015;10(9):e0136547.
32. Kristoffersen DT, Helgeland J, Waage HP, et al. Survival curves to support quality improvement in hospitals with excess 30-day mortality after acute myocardial infarction, cerebral stroke and hip fracture: a before-after study. *BMJ open* 2015;5(3):e006741.
33. Helsedirektoratet. Nasjonale faglige retningslinjer for behandling og rehabilitering ved hjerneslag. Oslo: Helsedirektoratet, 2017.
34. Berger VW, Zhou Y. Kolmogorov-smirnov test: Overview. *Wiley statsref: Statistics reference online* 2014
35. Hanglberger D. Arbeitszufriedenheit im internationalen Vergleich. <http://hdl.handle.net/10419/67925>: FFB-Diskussionspapier, 2011.
36. Weigl M, Stab N, Herms I, et al. The associations of supervisor support and work overload with burnout and depression: a cross-sectional study in two nursing settings. *Journal of Advanced Nursing* 2016;72(8):1774-88.

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37. McHugh MD, Rochman MF, Sloane DM, et al. Better nurse staffing and nurse work environments associated with increased survival of in-hospital cardiac arrest patients. *Medical care* 2016;54(1):74-80.
38. Faisy C, Davagnar C, Ladiray D, et al. Nurse workload and inexperienced medical staff members are associated with seasonal peaks in severe adverse events in the adult medical intensive care unit: A seven-year prospective study. *International Journal of Nursing Studies* 2016;62:60-70.
39. Aiken LH, Clarke SP, Sloane DM, et al. Hospital nurse staffing and patient mortality, nurse burnout, and job dissatisfaction. *Jama* 2002;288(16):1987-93.
40. McHugh MD, Ma C. Hospital nursing and 30-day readmissions among Medicare patients with heart failure, acute myocardial infarction, and pneumonia. *Medical care* 2013;51(1):52.
41. Kane RL, Shamliyan TA, Mueller C, et al. The association of registered nurse staffing levels and patient outcomes: systematic review and meta-analysis. *Medical care* 2007;45(12):1195-204.
42. Carayon P, Gurses AP. Nursing workload and patient safety—a human factors engineering perspective. In: RG H, ed. *Patient Safety and Quality: An Evidence-Based Handbook for Nurses*. Rockville (MD): Agency for Healthcare Research and Quality (US) 2008.
43. Tvedt C, Sjetne IS, Helgeland J, et al. An observational study: associations between nurse-reported hospital characteristics and estimated 30-day survival probabilities. *BMJ quality & safety* 2014;23(9):757-64. doi: 10.1136/bmjqs-2013-002781
44. West MA, Borrill C, Dawson J, et al. The link between the management of employees and patient mortality in acute hospitals. *International Journal of Human Resource Management* 2002;13(8):1299-310.
45. Edmondson A, Moingeon B. Learning, trust and organizational change. *Organizational learning and the learning organization* 1999:157-75.
46. Rosenbaum L. *Cursed by Knowledge—Building a Culture of Psychological Safety*: Mass Medical Soc, 2019.
47. Gutberg J, Berta W. Understanding middle managers' influence in implementing patient safety culture. *BMC health services research* 2017;17(1):582.
48. West M, Dawson J. *Employee engagement and NHS performance*: King's Fund London 2012.
49. Veronesi G, Kirkpatrick I, Altanlar A. Are Public Sector Managers a “Bureaucratic Burden”? The Case of English Public Hospitals. *Journal of Public Administration Research and Theory* 2018;29(2):193-209. doi: 10.1093/jopart/muy072
50. Conway J. Getting boards on board: engaging governing boards in quality and safety. *The Joint Commission Journal on Quality and Patient Safety* 2008;34(4):214-20.
51. Amalberti R, Auroy Y, Berwick D, et al. Five system barriers to achieving ultrasafe health care. *Annals of internal medicine* 2005;142(9):756-64.
52. Borzecki AM, Christiansen CL, Chew P, et al. Comparison of In-Hospital Versus 30-Day Mortality Assessments for Selected Medical Conditions. *Medical Care* 2010;48(12):1117-21. doi: 10.1097/MLR.0b013e3181ef9d53
53. Krumholz HM, Wang Y, Mattera JA, et al. An administrative claims model suitable for profiling hospital performance based on 30-day mortality rates among patients with an acute myocardial infarction. *Circulation* 2006;113(13):1683-92.
54. OECD. *Health at a glance 2013: OECD indicators*: OECD 2013.

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2  
3 55. Cecil E, Wilkinson S, Bottle A, et al. National hospital mortality surveillance system: a  
4 descriptive analysis. *BMJ quality & safety* 2018;bmjqs-2018-008364.  
5  
6 56. Tourangeau AE, Cranley LA, Jeffs L. Impact of nursing on hospital patient mortality: a  
7 focused review and related policy implications. *Quality and Safety in Health Care*  
8 2006;15(1):4-8. doi: 10.1136/qshc.2005.014514  
9  
10 57. Taylor N, Clay-Williams R, Hogden E, et al. High performing hospitals: a qualitative  
11 systematic review of associated factors and practical strategies for improvement.  
12 *BMC health services research* 2015;15(1):244.  
13  
14 58. Ioannidis JP, Munafo MR, Fusar-Poli P, et al. Publication and other reporting biases in  
15 cognitive sciences: detection, prevalence, and prevention. *Trends in cognitive*  
16 *sciences* 2014;18(5):235-41.  
17  
18 59. Shanafelt TD, Mungo M, Schmitgen J, et al. Longitudinal study evaluating the association  
19 between physician burnout and changes in professional work effort. *Mayo Clinic*  
20 *Proceedings* 2016;91(4):422-31.  
21  
22 60. Bognár A, Barach P, Johnson JK, et al. Errors and the burden of errors: attitudes,  
23 perceptions, and the culture of safety in pediatric cardiac surgical teams. *The Annals*  
24 *of Thoracic Surgery* 2008;85(4):1374-81.  
25  
26 61. Mohr J, Barach P. Understanding the design of health care organizations: The role of  
27 qualitative research methods. *Environment & Behavior* 2008;40:191-205.  
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### Footnotes

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37  
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3 **Ethical approval:** The study was approved by the Medical and Health Research Ethics  
4 Committee (REC) in South Eastern Norway with waiver of informed consent, since all data  
5 used in the study were anonymous. (Case number 2011/2345 D)  
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9 **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   |
|---------------------------|----------|--|----------|---|
| <b>Title and abstract</b> | 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        |   |
| <b>Introduction</b>       |          |  |          |   |
| 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.              |
| <b>Methods</b>            |          |  |          |   |
| 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) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up<br><i>Case-control study</i> —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<br><i>Cross-sectional study</i> —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.<br><br>* All adult patients admitted to hospital with AMI, stroke (>18 |

|                              |    |  |       |  |
|------------------------------|----|--|-------|--|
|                              |    |  |       | years) and hip-fracture (>65 years).   |
|                              |    | (b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed   |       |  |
|                              |    | <i>Case-control study</i> —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/<br>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.<br>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     | $Relative\ mortality\ rate_{unit} = \frac{Mean\ mortality\ rate_{patient\ group}}{Mean\ mortality\ rate_{unit}}$                       |
| 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) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed<br><i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed<br><i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy | NA    |  |
|                        |     | (e) Describe any sensitivity analyses   | NA    |  |
| <b>Results</b>         |     |   |       |  |
| 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) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)  |       |  |
| Outcome data           | 15* | <i>Cohort study</i> —Report numbers of outcome events or summary measures over time<br><i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure   |       |  |
|                        |     | <i>Cross-sectional study</i> —Report numbers of outcome events or summary measures  | 17,18 | See Tables 4 and 5   |

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| 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 |   |
| <b>Discussion</b>        |    |  |    |   |
| 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 |   |
| <b>Other information</b> |    |  |    |   |
| 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](http://www.strobe-statement.org).