Paper II

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Validity and reliability of the Hospital Survey on Patient Safety Culture and exploration of longitudinal change at a hospital

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Abstract - Hospital Survey on Patient Safety Culture (HSOPSC) has become the common instrument in assessing safety climate in health care but few studies have been published on the validity and reliability of the instrument. The aim of this study was to investigate the psychometric properties of HSOPSC at two measures and monitor longitudinal change during a two year period. The study was conducted at a Norwegian hospital offering a wide range of specialised health care services. The response rate was 55 percent (N=1919) with the first sample (*T*0) and 49 percent (N=1703) at the second sample (*T*1) two years later. Confirmatory factor analysis demonstrated that the HSOPSC factor structure was replicated at *T*0 and *T*1 separately. Pearson's *r* statistics and Cronbach's alpha also supported the validity and reliability of the instrument. Results using t-tests and MANOVA demonstrate that the safety climate level was relatively stable during the period under study, suggesting that implemented interventions have had relatively little impact on the safety climate dimensions. Three safety climate dimensions were improved, two were reduced, and five did not significantly change. However, small significant improvements on two of the three outcome measures were observed in regards to patient safety grade and stop working in dangerous situations. HSOPSC scales appear to have satisfactory psychometric properties. Findings further suggest that a high level of interventions will be needed to improve safety climate dimensions in hospital settings.

INTRODUCTION

Today it has become common to regard safety climate as an important indicator of organizational performance regarding safety in a wide range of industries, including health care. In health care, research regarding safety culture and climate has escalated since *To Err is Human* was published in 1999 (Institute of Medicine), which identified poor safety culture as one of the most important reasons for poor patient safety in health care. It further targeted safety culture improvement as one of the most important challenges for health care. Safety culture is defined as "the product of individual and group values, attitudes, perceptions, competencies to, and the style and proficiency of, an organization's safety management" (International Atomic Energy Agency, p. 23), while safety climate is regarded as "the surface features of the underlying safety culture [and] assesses workforce perceptions of procedures and behaviours in their work environment that indicate the priority given to safety relative to other organisational goals" (Flin, 2006, p. 109). Quite similarly, Zohar (2003) asserted that "safety climate relates to shared perceptions with regard to safety policies, procedures and practices" (p. 125). Safety climate is expected to predict the way in which employees behave with respect to safety in the workplace (Williamson, Feyer, Cairns, & Biancotti). Research suggests that safety climate links with safety behaviours and accident rates in a wide variety of settings (Clarke, 2006; Johnson, 2007; Lee, 1998; Mearns, Flin, Gordon, & Fleming; Zohar, 2000) including health care (Singer et al., 2009) and that safety climate improvement is possible

both during a one- and two-year period (Nielsen, Rasmussen, Glasscock, & Spangenberg, 2008; Tharaldsen, Olsen, & Rundmo, 2008).

Safety climate questionnaire data may be used as an indicator of aspects of the underlying safety culture (Flin et al, 2000) and may be used to track changes over time in healthcare settings (Nieva & Sorra, 2003). As there is growing international interest in managing organisational culture as a lever for healthcare improvement (Mannion, Konteh, & Davies, 2009), the aim of this study is to explore the psychometric properties of the most commonly used instrument to assess safety climate in hospital setting: Hospital Survey on Patient Safety Culture (Sorra & Nieva, 2004). The use of HSOPSC is currently widespread to at least 10 European countries (European Union Network for Patient Safety, 2009), but no studies have yet been published on the validity of the instrument in a European context. In this study the psychometric properties of HSOPSC will be investigated at two measures taken over a two-year period at a hospital, and a second aim is therefore also to evaluate if improvement efforts during the period have had any effects on the safety climate and outcome measures that are being explored in the study. The study will therefore also give insights into the difficulty or easiness of improving safety climate in hospital settings.

The first baseline measurement (*T*0) at the hospital indicated poor scores compared with American health care workers (Olsen, 2007); the Norwegian health care workers had less adequate scores on 7 out of 10

safety climate dimensions. In addition, Norwegian health care workers generally had poorer scores on the outcome variables measured with HSOPSC. Results indicated a need for the hospital studied in this study to improve the hospital's safety climate until the follow-up measure (*T*1) conducted two years after the baseline.

METHODS

Selection of instrument

HSOPSC was selected as an instrument because its dimensionality covered general topics revealed as part of a broader patient safety project (Aase et al, 2007; Høyland, 2007; Wiig & Aase, 2007; Olsen, 2008). Studies conducted in North America indicated good support for the psychometric qualities of HSOPSC compared to other instruments (Flin et al, 2006). HSOPSC consists of 2 single-item outcome measures and 2 overall patient safety outcome dimensions that have been assessed to validate 10 safety climate dimensions (Sorra and Nieva, 2004). The HSOPC items are rated on Likert-type scales with verbal anchors. All scales used in this study are measured on scales from 1 to 5. More details about HSOPSC are provided at www.ahrq.gov/qual/hospculture.

Before HSOPSC was used, the instrument was translated into Norwegian. To ensure the validity of the translation, the Norwegian version was also translated back into English by separate researchers. This process, combined with pilot testing on eight health care workers,

suggested that HSOPSC was adequate to assess safety climate in a Norwegian health care setting.

Based on tests of different psychometric criteria using *T*0 data, it was concluded that HSOPSC could be used in a longitudinal study of safety climate at the hospital (Olsen, 2008). However, the validity testing revealed that the number of events reported (during the last 12 months) and frequency of event reporting were less adequate to be used as outcome variables; thus, they were not used as such in this study. To compensate for this, a new outcome measure related to safety behaviour—namely, stop working in dangerous situations—was developed and used with both measurements. The four new items measuring this dimension were selected from another safety climate inventory (Norwegian Offshore Risk and Safety Climate Inventory) (Tharaldsen, Olsen, & Rundmo, 2008). Figure 1 illustrates the overall measurement model used in the study.

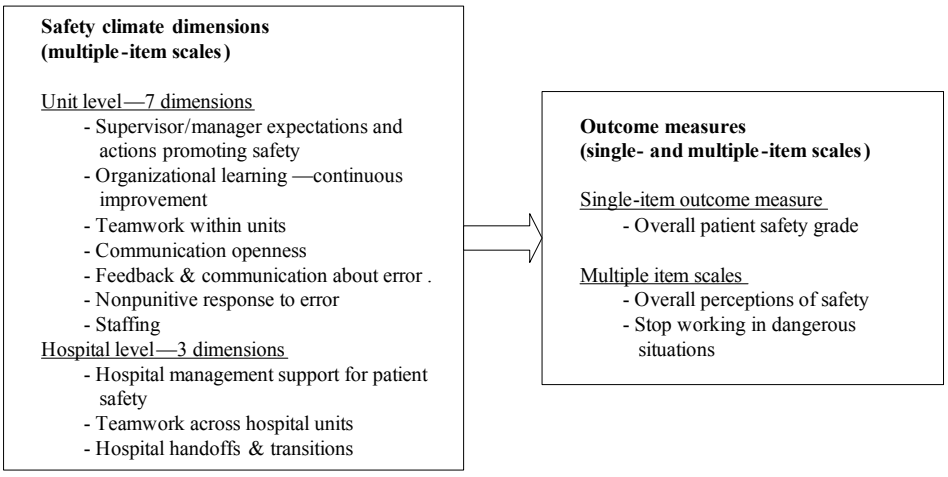

Figure 1 Measurement model used in the study.

Sample

The study was conducted in a relatively large regional Norwegian university hospital. The target group included health care workers at the hospital as well as other personnel employed primarily in the same working environment as the health care personnel. At *T*0, a total of 1919 workers answered the survey, resulting in a response rate of 55 percent. Of these respondents, 89 percent had direct patient contact, whereas 62 percent worked between 20 and 37 hours per week. Nurses with or without specialist education represented 45 percent of the sample, followed by physicians (11 percent). At *T*1 a total of 1703 workers answered the survey, resulting in a response rate of 49 percent; 89 percent of these had direct patient contact, whereas 60 percent worked between 20 and 37 hours per week. Like the first measure nurses with or without specialist education represented the largest share (42 percent) of the sample followed by physicians (11 percent).

Interventions

During the study period, no formal interventions occurred at the hospital. However, meetings with hospital personnel revealed that several safety-related efforts were initiated between *T*0 and *T*1. A new patient safety unit was established centrally at the hospital. One of the tasks assigned to this unit was to define strategies for the direction of patient safety and quality at the hospital. Furthermore, new positions for quality coordinators were established in all major clinical areas. The coordinators were expected to coordinate and follow up on patient

safety and quality issues as well as centrally function as contact points for the patient safety unit.

A new electronic system for reporting adverse events was implemented during the study period to improve learning from adverse events through better coordination and follow-up regarding safety-related issues. The aim of the adverse events reporting was to have regular discussion of the events at quality committee meetings within the different clinical areas.

The hospital sought to focus on other safety-related topics at different levels on an ongoing basis. Examples of such topics included leadership development training, patient handoffs and transitions, correct use of medications, reduction of infections, and clinical revisions of standards (from patient safety unit strategy). Most of the improvement efforts described herein are generally related to technological and safety management improvements.

Statistical analysis

AMOS 7 (Arbuckle, 2006) was used to perform confirmatory factor analysis (CFA), which was tested separately on both samples (*T*0 and *T*1). The fit measures applied included Comparative Fit Index (CFI), Root Mean Square Error of Approximation (RMSEA), Goodness of Fit Index (GFI), and Adjusted Goodness of Fit Index (AGFI). The remaining analysis of the data was generated using SPSS 15.0. Missing data were handled with the series mean procedure in SPSS before CFA was estimated using AMOS 7. Composite scale scores for the 12 safety

climate dimensions were created prior to the treatment of missing data by obtaining the mean of the responses to items in the dimension after reverse coding the reverse items (Sorra & Nieva, 2004). Consequently, 1 is the lowest possible score on composite scores, while 5 is the highest. Cronbach's alpha was estimated to determine whether factor scales yielded acceptable alpha coefficients and internal consistency at measures *T*0 and *T*1. Pearson's *r* was estimated to examine the discriminant and convergent validity among measures. To measure change, MANOVA (Wilks' Lambda) was conducted to examine if *T*0/*T*1 had overall influences on HSOPSC concepts between *T*0 and *T*1. Finally, independent sample t-tests were utilized to investigate changes between *T*0 and *T*1.

RESULTS

Concept validity and reliability

Table 1 provides CFA and Cronbach's alpha scores. CFA indicated that the factorial model acceptably fitted the data at both *T*0 (RMSEA = 0.041, CFI = 0.91, GFI = 0.92, AGFI = 0.91) and *T*1 (RMSEA = 0.041, CFI = 0.91, GFI = 0.92, AGFI = 0.91). Generally speaking, the factor loadings were satisfactory. The lowest loading was from "Organizational learning—continuous improvement" with the item "mistakes have led to positive changes here" at both *T*0 (0.27) and *T*1 (0.33). The study also investigated whether a second and third order factor fitted the *T*0 and *T*1 samples separately; however, such models did not satisfactorily fit the data.

Correlations among the 10 safety climate dimensions varied between .17 and .59 ($p < .01$) at *T*0 and .17 and .56 ($p < .01$) at *T*1. "Feedback and communication about error" and "Communication openness" were the highest correlated dimensions among the safety climate dimension for both measures. "Overall perceptions of safety" was expected to be significantly correlated with "Patient safety grade"; the data supported this expectation for both *T*0 (.68, $p < .01$) and *T*1 (.66, $p < .01$). As expected, the correlations within the outcome variables as well as between the safety climate scales and the outcome variables were positively correlated, indicating better levels of safety outcomes when more positive scores existed on the safety climate dimensions.

The Cronbach's alpha scores ranged from .51 to .82 at *T*0 and from .53 to .82 at *T*1 (see Table 1). Organizational learning—continuous improvement has the lowest alpha score at both *T*0 (.51) and *T*1 (.53).

Table 1 Dimensional structure of HSOPSC, Cronbach's alpha, and factorial loadings at *T*0 and *T*1

Dimensions and items	Loadings	
	*T*0	*T*1
Organizational Learning—Continuous Improvement		
Cronbach's alpha: T0 = 0.51, T1 = 0.53		
We are actively doing things to improve patient safety	0.70	0.65
Mistakes have led to positive changes here	0.27	0.33
After we make changes to improve patient safety, we evaluate their effectiveness	0.62	0.62
Teamwork Within Units		
Cronbach's alpha: T0 = 0.77, T1 = 0.74		
When one area in this unit gets really busy, others help out	0.53	0.48
In this unit, people treat each other with respect	0.75	0.76
When a lot of work needs to be done quickly, we work together as a team to get the work done	0.64	0.58
People support one another in this unit	0.78	0.79
Frequency of Events Reported		
Cronbach's alpha: T0 = 0.82, T1 = 0.75		
When a mistake is made, but is caught and corrected before affecting the patient, how often is this reported?	0.80	0.78
When a mistake is made, but has no potential to harm the patient, how often is this reported?	0.78	0.79
When a mistake is made that could harm the patient, but does not, how often is this reported?	0.74	0.73
Teamwork Across Units		
Cronbach's alpha: T0 = 0.65, T1 = 0.68		
Hospital units do not coordinate well with each other	0.63	0.63
It is often unpleasant to work with staff from other hospital units	0.58	0.59
There is good cooperation among hospital units that need to work together	0.57	0.60
Hospital units do not coordinate well with each other	0.48	0.53
Handoffs & Transitions		
Cronbach's alpha: T0 = 0.65, T1 = 0.68		
Shift changes are problematic for patients in this hospital	0.41	0.43
Problems often occur in the exchange of information across hospital units	0.71	0.72
Important patient care information is often lost during shift changes	0.54	0.56
Things "fall between the cracks" when transferring patients from one unit to another	0.58	0.60
Communication Openness		
Cronbach's alpha: T0 = 0.68, T1 = 0.65		
Staff will freely speak up if they see something that may negatively affect patient care	0.61	0.59
Staff feel free to question the decisions or actions of those with more authority	0.73	0.71

Dimensions and items	Loadings	
Staff are afraid to ask questions when something does not seem right	0.59	0.56
Feedback & Communication About Error		
Cronbach's alpha: T0 = 0.70, T1 = 0.69		
We are given feedback about changes put into place based on event reports	0.50	0.45
We are informed about errors that happen in this unit	0.65	0.68
In this unit, we discuss ways to prevent errors from happening again	0.82	0.80
Staffing		
Cronbach's a: T0 = 0.65, T1 = 0.68		
We work in "crisis mode", trying to do too much, too quickly	0.72	0.79
We use more agency/temporary staff than is best for patient care	0.44	0.48
Staff in this unit work longer hours than is best for patient care	0.48	0.50
We have enough staff to handle the workload	0.64	0.65
Nonpunitive Response to Error		
Cronbach's a: T0 = 0.64, T1 = 0.67		
Staff feel like their mistakes are held against them	0.65	0.68
When an event is reported, it feels like the person is being written up, not the problem	0.63	0.71
Staff worry that mistakes they make are kept in their personnel file	0.54	0.52
Management Support for Patient Safety		
Cronbach's a: T0 = 0.79, T1 = 0.78		
Hospital management provides a work climate that promotes patient safety	0.77	0.77
The actions of hospital management show that patient safety is a top priority	0.81	0.82
Hospital management seems interested in patient safety only after an adverse event happens	0.65	0.63
Supervisor/Manager Expectations & Actions Promoting Patient Safety		
Cronbach's alpha: T0 = 0.77, T1 = 0.76		
My supervisor/manager overlooks patient safety problems that happen over and over	0.65	0.66
Whenever pressure builds up, my supervisor/manager wants us to work faster, even if it means taking shortcuts	0.50	0.47
My supervisor/manager seriously considers staff suggestions for improving patient safety	0.84	0.81
My supervisor/manager says a good word when he/she sees a job done according to established patient safety procedures	0.73	0.72
Overall Perceptions of Patient Safety		
Cronbach's alpha: T0 = 0.76, T1 = 0.75		
Patient safety is never sacrificed to get more work done	0.52	0.49
It is just by chance that more serious mistakes don't happen around here	0.73	0.75
We have patient safety problems in this unit	0.74	0.76
Our procedures and systems are good at preventing errors from happening	0.68	0.66

Differences between *T*0 and *T*1

MANOVA and t-test statistics were conducted to investigate the differences in safety climate and safety outcomes between *T*0 and *T*1. MANOVA revealed an overall difference in the safety climate between the two measures when the 10 dimensions are defined as dependent variables and the time for measurement defined as a dichotomized (*T*0 vs. *T*1) independent variable: Wilks' Lambda of 0.972 (df=10), $p<0.001$, effect size=0.28 (Eta^2). Hence, results generally indicate that the safety climate differs at *T*0 compared to *T*1. MANOVA, using the same dichotomized independent variable, also revealed an overall difference in the three outcome variables used in the study: Wilks' Lambda of 0.997 (df=3), $p<.05$, effect size=0.003 (Eta^2).

Table 2 outlines mean differences and t-tests. These analyses provide additional information to MANOVA results because t-tests estimate if the results of the measures significantly differ for each measurement concept. The t-test analyses indicate small significant improvements on two outcome measures: patient safety grade and stop working in dangerous situations. Four significant safety climate changes were reported at the unit level—all positive with the exception of staffing. At the organizational level, organizational management support for patient safety had a significantly lower score at *T*1. Change between *T*0 and *T*1was also investigated in regards to the number of events reported (last 12 months) and frequency of event reporting, but this did not result in any significant result.

To investigate if changes could be on a lower level at the hospital, t-

tests ($p < .05$) were additionally estimated separated for 10 different occupational categories. The results supported the general impression of safety climate stability across different occupations. The exception was for a category consisting of bioengineers and radiographs. For this work groups the trend was positive significant improvements: Five safety climate scores and two outcome measured were significantly improved for the bioengineer and radiographs category.

Table 2: Descriptive statistics and mean differences between *T*0 and *T*1

	*T*0		*T*1		*T*0—*T*1	
	Mean	St.d.	Mean	St.d.	Mean diff.	Sig
Outcome measures						
Patient safety grade	3.44	0.67	3.48	0.67	-0.04	*
Overall perceptions of patient safety	3.50	0.74	3.53	0.71	-0.02	
Stop working in dangerous situations	3.84	0.55	3.89	0.55	-0.04	*
Safety climate dimensions—unit level						
Supervisor/manager expectations & actions promoting safety	3.82	0.68	3.92	3.93	-0.10	***
Organizational learning—continuous improvement	3.37	0.64	3.40	3.41	-0.04	
Teamwork within hospital units	3.84	0.60	3.92	3.91	-0.05	*
Communication openness	3.71	0.65	3.76	3.77	-0.04	
Feedback and communication about error	3.24	0.76	3.23	3.24	0.01	
Nonpunitive response to error	3.81	0.65	3.91	3.90	-0.10	***
Staffing	3.26	0.79	3.27	3.28	0.09	**
Safety climate dimensions—organizational level						
Organizational management support for patient safety	2.85	0.82	2.76	2.79	0.13	***
Teamwork across units	2.98	0.62	3.11	3.11	0.01	
Organizational handoffs and transitions	3.02	0.66	3.20	3.19	0.03	

DISCUSSION

Concept validity and reliability

The first aim of this study was to investigate the use of a safety climate instrument in a Norwegian hospital setting. HSOPSC was chosen because earlier studies have indicated satisfactory psychometric properties for this instrument; however, this has never been tested in European nor Norwegian hospital settings.

The results demonstrated that the HSOPSC factor structure can be valid not only in a United States-based health care facility (Sorra and Nieva, 2004), but also in a Norwegian hospital setting. The replication of the instrument factor structure at both *T*0 and *T*1 generally confirms the robustness and validity of the measurement model. As a second or third order factor model did not satisfactorily fit the data, it can only be recommended to use the first order solution to investigate change over time and other forms of benchmark statistics.

The original first order solution nicely fitted the data at both measurements of this study. The only slight problem that can be tracked is the loading below .30 from "Organizational learning—continuous improvement" on the item "mistakes have led to positive changes here". Not surprisingly, Cronbach's alpha was also somewhat lower for this scale. However, interpretations of Cronbach's alpha should consider the weakness of the alpha scale: the estimation of the reliability scale is underestimated when few items are incorporated into the estimation (Cronbach, 1951). As the scales in this study are based only on three or four items, the alpha scores should be considered

satisfactory.

The overall results indicate that HSOPSC measures conceptual different dimensions and aspects of safety climate; moreover, the instrument can be used to measure the stability and changeability of safety climate in a Norwegian hospital context.

Differences between *T*0 and *T*1

The second aim of this study was to monitor the safety climate in a Norwegian hospital longitudinally to determine if the hospital would be able to improve its safety climate and safety outcomes over a two-year period. Earlier studies documented the possibility of improving safety climate during this period (Tharaldsen, Olsen, & Rundmo, 2008) or even less time (Nielsen et al., 2008); thus, some change could be expected. Although the case hospital took the initiative to implement different safety improvements between *T*O and *T*1, this did not necessarily indicate that the hospital would have a positive trend from the first to the second measurement. In the research literature it is often emphasised how difficult it is to improve organisational culture (Schein, 1999), safety culture (Columbia Accident Investigation Board, 2003) and organizational change (Kotter, 1995) in general.

MANOVA indicate overall differences in the safety climate dimensions and the outcome measures separately. The t-test statistics revealed that the changes were primarily related to small improvements in three dimensions (supervisor/manager expectations & actions promoting safety, teamwork within hospital units, and nonpunitive

response to error), decreases on two (organizational management support for patient safety and staffing), and no significant change on the five remaining safety climate dimensions. These results indicate that the hospital has been more successful in improving its safety climate at the unit level compared to the organizational level. The t-test statistics further point out two significant improvements in the outcome variables—namely, patient safety grade and stop working in dangerous situations. The overall impression of the hospital study is a small general improvement that is particularly emphasized by the improvement to the two outcome measures and three of the safety climate measures at the unit level. These results suggest specific positive influences on the safety initiatives implemented during the period under study.

However, the positive trend is contradicted by small but significant decreases in organizational management support for patient safety and staffing. This may be explained by a focus on cutting costs at the hospital during the period under study, when even downsizing was mentioned as an alternative. It is reasonable to believe such focus can influence organizational management support for patient safety and the staffing dimensions in a negative direction.

These results indicate that the level of safety climate and outcome measures remained relatively stable during the two-year period the hospital was monitored. Results from the baseline measurement indicated a need to improve the hospital's safety climate compared to hospitals in the United States (Olsen, 2008; Aase et al., 2008).

Therefore, the relative stability of the safety climate is somewhat disappointing, especially given the positive link between safety climate and positive safety outcomes emphasised in various studies (Clarke, 2006; Jonhson, 2007; Lee, 1998; Mearns et al., 1998; Zohar, 2000; Singer, et al., 2009; Nielsen et al., 2008; Tharaldsen, Olsen & Rundmo, 2008).

Although several safety initiatives were intended to be implemented during the study period, results indicate that more extensive organizational change, different interventions, or a more thorough implementation is necessary to improve the level of HSOPSC measures more extensively. This assertion is in accordance with the results of another study (Olsen, Bjerkan, & Nævestad, 2009), which emphasised the significance and importance of a comprehensive implementation of safety programme activities to increase the likelihood of cultural and behavioural effects concerning safety. This likelihood increased with higher levels of worker commitment to the safety interventions.

Implications for improving the quality of care

The findings of this study support that the psychometric properties of HSOPSC generally are satisfactory. Results therefore suggest that HSOPSC can be used to diagnose and assess trends regarding safety climate in specialised health care settings both to evaluate issues regarding patient safety, and to evaluate effects and trends with regard to improvement efforts. The longitudinal design of this study demonstrates this; the baseline measurement indicates a relatively poor

safety climate at the hospital compared to North American hospitals. Secondly, the second measurement indicates that improvement efforts had minor effects and that stronger of different improvement measures should have been used. Personnel working with quality and safety in health care should be aware that comprehensive efforts probably depending on availability of considerable organisational slack (Nadler, 1993; Morgan, 1989), are needed to change and improve safety climate factors in specialised health care settings.

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