Paper I

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Reliability and Validity of the Hospital Survey on Patient Safety Culture at a Norwegian Hospital

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ABSTRACT

Main research question: The core aim of the present study was to translate and test the validity and reliability of the Hospital Survey on Patient Safety Culture (HSOPSC) in Norwegian health care.

General design and sample: The study was conducted among employees at a large hospital in Norway that offers a wide range of hospital services organized into 10 clinics.

Data collection and analysis methods: HSOPSC (Sorra & Nieva, 2004) was translated into Norwegian and used to measure the safety culture among the main target groups — namely, health and mercantile workers employed in the health care environment; 1919 questionnaires were returned, resulting in a response rate of 55 percent. Confirmatory factor analysis (CFA) was utilised to investigate the fit of the proposed factor structure, and Cronbach's alpha was determined to examine the internal consistency of dimensions. Furthermore, the intercorrelation among concepts and MANOVA were conducted to investigate discriminate validity. Finally, concurrent validity was examined to verify the degree to which the safety culture dimensions influenced the outcome variables included in HSOPSC.

Main findings: Confirmatory factor analyses indicated that the factorial model fitted the data well. One dimension, "Organizational learning — continuous improvement", indicated unsatisfactory internal consistency, although the internal consistency improved when the item "mistakes have led to positive changes here" was removed from the dimension. Contrary to established expectations, the safety culture dimension exerted several negative influences on "Number of events reported (last 12 months)", indicating that this outcome

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variable is invalid. "Patient safety grade" and "Overall perceptions of safety" seemed to be the most valid outcome variables.
Methodological challenges: The greatest methodological challenges facing the study were using the correct statistical procedures and methods so that Type I and Type II errors were avoided.
Practical challenges: The most practical challenge of this study was achieving a high survey response rate among hospital staff.
Main lessons for other researchers: The study indicated that the psychometric properties of HSOPSC are satisfactory and that the instrument can be used in Norwegian hospital settings. However, users should be aware that the internal consistency is lower for the dimension "Organizational learning — continuous improvement" and that "Number of events reported" is probably dysfunctional as an outcome measure.

Keywords: Safety culture; Safety climate; Validity; Reliability; Safety performance; Patient safety

Introduction

Safety culture has been regarded as one of the most important premises for the further improvement of patient safety in health care (Corrigan et al., 1999). Generally speaking, the survey method appears to be the predominant strategy for studying organizational cultures, and their effects on safety. The term culture is often replaced with climate when questionnaire surveys are used to assess an organizations' culture. The survey method is well suited for studying individual attitudes and values as well as practices — "the way people do things around here" (Hopkins, 2006: p. 878). Interest in measuring the safety culture has generated several instruments for use in health care settings. Such instruments normally incorporate several dimensions; most adopt a "generalist" focus designed to address several safety issues in a variety of hospital areas, while psychometric techniques are commonly used to ensure potential users that instruments will be a good predictor of safety events and provide actionable information (Singla et al., 2006).

Grasping the concept of safety culture is challenging as it is concerned with work practices concerning safety as well as how individuals think, act, and cooperate concerning safety (Cooper, 2000). Confusion within scientific areas often relates to a lack of evidence concerning reliability and validity. As health care safety culture/ climate instruments are increasingly being used on a large scale throughout health care organizations, it is becoming increasingly important to obtain information

about the psychometric properties of such instruments (Flin et al., 2006). Validity concerns come even more into question when questionnaires are translated into other languages, especially since environmental differences might exist at the national level (Hutchinson et al., 2006). These factors make it important to investigate whether or not the dimensional structure of safety culture instruments can be replicated in various organizational and international contexts. To ensure that survey instruments are valid and reliable, instruments developed in one context should ideally always be validated before extensive use in a new context (Pronovost & Sexton, 2005).

The main research question of this paper is to investigate the psychometric properties of Hospital Survey on Patient Safety Culture (HSOPSC) in a Norwegian health care setting. Results from a review of different instruments have shown that HSOPSC, when compared with other instruments, meets more psychometric criteria (Flin et al., 2006). Still, it is unclear if the reliability and validity of the instrument will be replicated in a Norwegian health care setting.

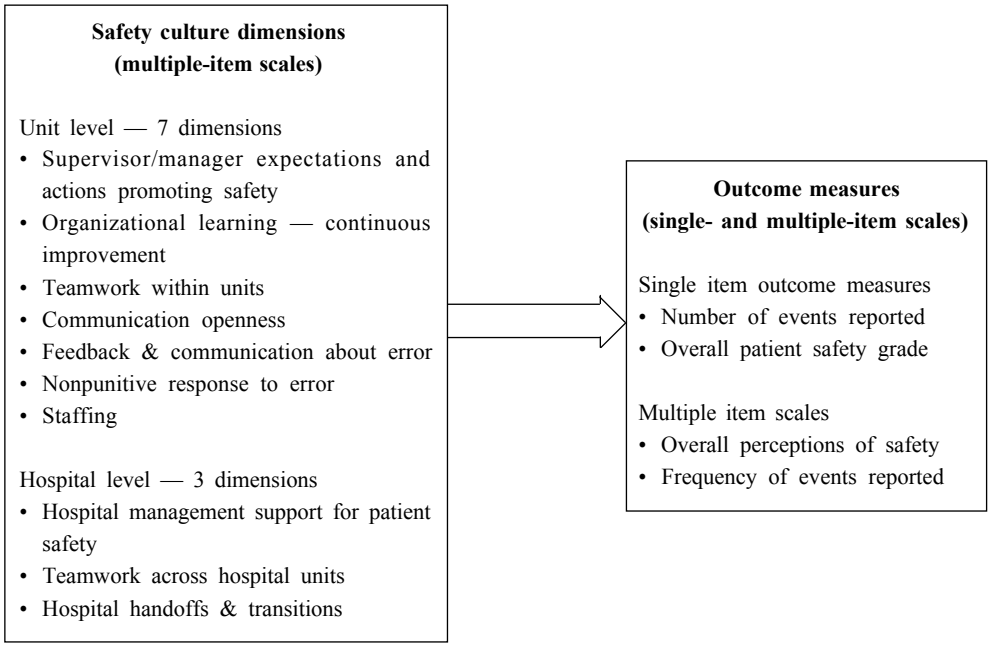
Data collection and analysis meyhods

Selection of instrument

A review of available safety culture instruments was conducted; HSOPSC was selected as the instrument for testing for three reasons. First, the dimensionality of HSOPSC covers general topics revealed as part of a broader patient safety project (Thomassen et al., 2005). Second, as noted earlier, studies show that HSOPSC has met more psychometric criteria compared to other instruments (Flin et al., 2006). Third, benchmark statistics of HSOPSC can be retrieved from the internet (AHRQ, 2007).

HSOPSC was developed based on a literature review, an examination of existing published and unpublished safety culture instruments, and psychometric analyses from the Veteran's Administration Patient Safety Questionnaire and the transfusion safety culture survey. The final version of HSOPSC consists of two single-item outcome measures and two overall patient safety outcome scales that were assessed to validate ten safety culture dimensions (Sorra & Nieva, 2004). All items in HSOPSC are rated on Likert-type scales with verbal anchors. "Number of Events Reported (last 12 months)" is measured on a scale from 1 to 6; all other concepts are measured on scales from 1 to 5. Figure 1 summarizes the safety culture dimensions and outcome variables measured with HSOPSC. Additional details about HSOPSC are available at www.ahrq.gov/qual/hospculture.

Figure 1
Safety culture dimensions and outcome variables measured with HSOPSC



Translation and pilot testing

HSOPSC was translated into Norwegian and then translated back into English by two independent researchers to ensure validity of the translation. In the translation process, it was stressed that the same meaning and "strength" should be reproduced in the translation into the Norwegian language. In order to test if respondents understood the meaning of all items, HSOPSC was pilot tested in a group of eight health care workers.

Distribution of items

The degree of missing values on items and skewness were also used as indicators of usability. The missing criteria were estimated so that no more than 10 percent of respondents would skip items. Skewness was defined so that 85 percent of the sample would not answer on one end (1 or 5/6) of the scales.

Sample

The study was carried out in a Norwegian hospital. The target group included health workers at the hospital and other personnel employed in the same working environment as the health care personnel. A total of 1919 workers answered the survey, resulting in a response rate of 55%. Of these respondents, 89% had direct patient contact, whereas 62% worked between 20 and 37 hours per week. Nurses with or without specialist education represented 45% of the total sample. The pilot testing of HSOPSC in a group of health care workers (N = 8) did not reveal any problematic items. In addition, informal dialogs with health care workers supported the usability and relevance of items to the broader patient safety and safety culture issues.

Analysis of data

Conventional validation strategies were undertaken (DeVillis, 2003; Hinkin, 1995, 1998; Netemeyer et al., 2003) in order to assess the validity of HSOPSC. Utilising CFA with Maximum Likelihood method, the dimensionality was assessed to investigate if all dimensions loaded as expected on their respective items. Items were treated as continuous variables, missing responses were deleted list-wise, and covariation was allowed between dimensions.

As explained by Sorra & Nieva (2004), composite scale scores for the 12 safety culture dimensions were created by obtaining the mean of the responses to items in the dimension after reverse coding of the reverse items. One is the lowest possible score on composite scores, and five is the highest. Several analysis were conducted after negative items were reversed. The Cronbach's alpha was estimated to determine if factor scales yielded acceptable alpha coefficients and internal consistency. Pearson's *r* was estimated to examine the discriminate and convergent validity among measures. MANOVA (Wilks' Lambda) was conducted to examine if different work characteristics had overall effects on HSOPSC concepts (discriminate validity). A regressions analysis was conducted to investigate if the safety culture dimensions influenced the outcome variables as expected (concurrent validity). CFA were conducted using linear structural relation (LISREL) analysis, whose core aim was to judge the goodness of fit of the factorial model. Structural Equational Modelling made simple (STREAMS) was used for the LISREL analysis (Gustafsson & Stahl, 2000). The remaining results were generated using SPSS 13.0.

Results

Descriptive statistics

Table 1 presents the mean statistics and 95% confidence interval (CI) for each of the measurement concepts. The mean score for all concepts ranged from 1,84 to 3,84; most of the mean scores on the safety culture dimensions were above 3, which is the midpoint of the measurement scales. All items were satisfactory when it came to the missing and skewness criteria, indicating no need to remove any items based on these criteria. Skewness was highest for the variable "Frequency of event reporting"; 45% of respondents did not report any events during the last 12 months.

Internal consistency reliabilities

With one exception, Cronbach's alpha scores ranged from .64 to .82, which are considered satisfactory (Table 1). Only "Organizational learning — continuous

Table 1
Number of items, descriptive statistics, 95% CI and Cronbach's alpha

MEASUREMENT CONCEPTS	NUMBER OF ITEMS IN SCALE	MEAN	95% CI	ALPHA
4 outcome measures				
Patient safety grade	1	3,44	3,41 to 3,47	—
Number of events reported (last 12 months)	1	1,84	1,80 to 1,89	—
Overall perceptions of safety	3	3,50	3,46 to 3,53	.76
Frequency of event reporting	3	2,89	2,85 to 2,93	.82
Safety culture dimensions — unit level				
Supervisor/manager expectations & actions promoting safety	4	3,82	3,79 to 3,85	.77
Organizational learning — continuous improvement	3	3,37	3,34 to 3,40	.51
Teamwork within hospital units	4	3,84	3,82 to 3,87	.77
Communication openness	3	3,71	3,68 to 3,74	.68
Feedback and communication about error	3	3,24	3,21 to 3,27	.70
Nonpunitive response to error	3	3,81	3,79 to 3,84	.64
Staffing	4	3,35	3,32 to 3,38	.65
Safety culture dimensions — hospital level				
Hospital management support for patient safety	3	2,90	2,87 to 2,94	.79
Teamwork across hospital units	4	3,11	3,09 to 3,14	.65
Hospital handoffs and transitions	4	3,21	3,18 to 3,23	.65

improvement" had a lower alpha score (.51); however, the alpha score for this dimension did increase to .60 when the item "mistakes have led to positive changes here" was removed from the dimension[1].

Confirmatory factor analyses

CFA were conducted to determine if latent variables loaded as expected on the observed variables. Widely used goodness of fit indices indicated that the measurement model acceptably fitted the data (RMSEA = 0.044, CFI = 0.97, GFI = 0.91, AGFI = 0.90). Generally speaking, factor loadings were satisfactory. The lowest loading — from "Organizational learning — continuous improvement" with the item "mistakes have led to positive changes here" — was 0.29.

Discriminate and convergent validity

Correlations among the 10 safety culture dimensions varied between .17 and .59 ($p < .01$). It was expected that "Overall perceptions of safety" would be highly correlated with "Patient safety grade". This was supported in the data (.68, $p < .01$). "Feedback and communication about error" and "Communication openness" were the highest correlated dimensions (.59) among the safety culture dimension.

Results using MANOVA (Wilks' Lambda) indicated that all work characteristics (work area, length of services at the hospital, length of services in work area, hours per week, position, and patient contact) significantly ($p <.001$) explained the variance of the HSOPSC concepts.

Concurrent validity

Concurrent validity concerns to what degree phenomenon covariates with other related phenomena at the time of distribution (Netemeyer et al., 2003). Four regression analyses were conducted to determine if the ten safety culture dimensions influenced the four outcome variables as expected (Table 2). "Number of events reported (last 12 months)" was most weakly influenced by the safety culture dimensions. The ten safety culture dimensions had generally positive effects on the other three outcome variables;

[1] In order to test the original factorial model of HSOPS, this item was not removed before conducting the remaining analyses.

Table 2
Regression analyses testing the concurrent validity of HSOPSC

PATIENT SAFETY DIMENSIONS	OUTCOME VARIABLES			
	NUMBER OF EVENTS REPORTED (LAST 12 MONTHS)	PATIENT SAFETY GRADE	FREQUENCY OF EVENT REPORTING	OVERALL PERCEPTIONS OF PATIENT SAFETY
	Beta	Beta	Beta	Beta
1. Supervisor/manager expectations & actions promoting safety	–.03	**.14*****	.05	**.13*****
2. Organizational learning — continuous improvement	**.08****	**.13*****	**.11*****	**.16*****
3. Teamwork within hospital Units	**–.06***	**.06***	.00	.02
4. Communication openness	.01	**.08****	–.05	.03
5. Feedback and communication about error	**.11*****	.03	**.33*****	.04
6. Nonpunitive response to Error	**.06***	–.04	–.01	**.08*****
7. Staffing	**–.11*****	**.27*****	**–.07*****	**.36*****
8. Hospital management support for patient safety	–.04	**.17*****	**.12*****	**.18*****
9. Teamwork across hospital units	–.03	**.09*****	–.05	**.06****
10. Hospital handoffs and Transitions	–.05	–.00	.01	.02
Explained variance (R2)	.04	.42	.18	.54

* $p < 0.05$;
** $p < 0.01$;
*** $p < 0.001$. Significant coefficients are bolded.

however, contrary to expectations, the results revealed some significant negative influences on the outcome variables. “Hospital handoffs and transitions” was the only variable with no significant influences. The explanatory power was greatest for “Patient safety grade” (.42) and “Overall perceptions of patient safety” (.54).

Discussion

Pilot testing

In order to make HSOPSC useful in a Norwegian health care setting, it is crucial that items be clear and unambiguous to workers. Generally, results did not reveal any problematic items; therefore, it is fair to justify the usability of the Norwegian

version of HSOPSC. In addition, informal dialogs with health care workers concerning the content of HSOPSC provided further important support for the usability of HSOPSC.

Distribution on items

Statistical variation on items is important as it is a fundamental condition required for many statistical tests (Stone, 1978). Moreover, using items with low variance is problematic because doing so takes away the intention of conducting benchmark studies if no variance exists between groups. Therefore, it is important to note that all items were satisfactory in regards to the missing and skewness criteria, indicating no need to remove or adjust any items based on poor distribution.

Internal consistency reliabilities

Previous studies have revealed that using five-point scales on items is advantageous for achieving satisfactory coefficient alpha scores (Lissitz & Green, 1975). In the current study, with the exception of "Organizational learning — continuous improvement", alpha scores ranged from .64 to .82, which is considered satisfactory. Removing the item "mistakes have led to positive changes here" increased the alpha score on "Organizational learning — continuous improvement" from 0.51 to 0.60, which suggests that this item should be removed. However, removing it will reduce the possibility of comparing results on this dimension with benchmark data. Moreover, less than three items for a dimension is usually not recommended (Flin et al., 2006).

Confirmatory factor analysis

Cultural and contextual differences between the United States and Norway made it far from certain that the factorial structure of HSOPSC would be reproduced at the Norwegian hospital. Widely used goodness of fit indices indicated that the measurement model acceptably fitted the data. Results from CFA, therefore, support the argument that the factorial structure of HSOPSC is replicable in a Norwegian health care setting. It is reassuring that the factorial structure of HSOPSC is robust across different cultures and after translation into Norwegian, as this makes it possible to compare studies in Norway with U.S.

benchmark data (AHRQ, 2007). In addition, the robustness of the factorial structure makes it more reasonable to conduct longitudinal studies for measuring change over time on stable factors.

The lowest loading (0.29), from "Organizational learning — continuous improvement" on "mistakes have led to positive changes here", corresponds with the low alpha score (0.51) on this dimension. Therefore, it is not surprising that this dimension loaded relatively low on this item. Loadings below 0.30 are not considered optimal because it means that less than 9 percent of that item's variance is shared with the factor (Comrey and Lee, 1992).

Discriminate and convergent validity

Composite scores on the 10 safety culture dimensions ranged from 1.0 (lowest) to 5.0 (highest). The HSOPSC dimensions all measure various aspects related to the phenomena of safety culture/climate. It was expected that composite scores on the safety culture dimension would correlate to some degree. However, correlations should not be too high as this will indicate that dimensions measure almost the same concept (Sorra and Nieva, 2004) and show low evidence of discriminate validity (Hinkin, 1998).

Correlations among the 10 safety culture dimensions varied from .17 to .59 ($p < .01$). These correlations are considered satisfactory and do not indicate problematic associations among dimensions. The strongest correlation was between "Feedback and communication about error" and "Communication openness" (0.59). Considering that both dimensions share some attention towards communication, this outcome was not surprising; because it was conceptually meaningful, these concepts were not integrated into one concept.

Similarly correlating constructs support the evidence for convergent validity (Hinkin, 1998). It was therefore expected that "Overall perceptions of safety" would be highly correlated with "Patient safety grade", as in the pilot study conducted by Sorra and Nieva (2004). This finding was reproduced in the current study (.68, $p < 0.01$). "Overall perceptions of safety" and "Patient safety grade" are highly associated concepts; the high correlation between these concepts indicates convergent validity for both concepts.

Results using MANOVA provided further support for the discriminate validity of HSOPSC as the different work characteristics had generally significant effects on HSOPSC concepts. This is important as it was expected that perceptions of safety culture varied based on different worker and organisational characteristics (Huang et al., 2007).

Concurrent validity

Regression analysis revealed that "Number of events reported" does not function well as an outcome variable. Forty-five percent of the sample did not report any events. Contrary to Sorra and Nieva (2004), we see no reason to believe that the lack of association with this outcome variable is due to a lack of variability or extreme skewness in the number of events reported. A more probable reason is that "Number of events reported" does not capture the actual risk level due to the poor culture of reporting in health care. Nevertheless, the present data concur with Sorra and Nieva's assertion that the best use of this one-item measure is to use it as a change measure in order to monitor if staff members report more events over time.

With a few exceptions, the ten safety culture dimensions had positive influences on the other three outcome variables. This should be interpreted as better scores on safety culture dimensions positively influence safety outcomes: higher levels on the "Patient safety grade", higher "Frequency of (no harm) event reporting", and higher levels on "Perceptions of patient safety".

Some safety culture dimensions negatively influenced the outcome variables. Several reasons can explain this. Perhaps improved staffing will decrease near misses, thereby reducing the need to report and consequently the frequency of reported events. The negative influences on "Number of events reported (last 12 months)" probably relates to the general problem with the use of this measure as a criterion variable.

The general impression is that "Number of events reported (last 12 months)" does not function well as a criterion measure. The consistent influences on "Patient safety grade", "Frequency of event reporting" and "Overall perceptions of patient safety" supports both the validity of the safety culture dimensions and these outcome measures. Most significant influences are associated with the "Patient safety grade" and "Overall perceptions of patient safety"; therefore, these variables seem to be the most valid outcome measures. Meanwhile, "Hospital handoffs and transitions" seem to be the dimension with the lowest explanatory power. The evidence for the validity of this dimension therefore seems weaker.

Limitations of the study

The validity of this study is limited to self-reported outcome variables (concurrent validity), which is not optimal due to the possibility of common method bias (Podsakoff et al., 2003). Some precautions should therefore be taken as HSOPSC dimensions have not been validated against other patient safety indicators, such as actual reporting of adverse events on subsequent occasions (predictive validity). Until

HSOPSC has been validated against other criterion measures, the full impact of resulting data on different organisational risk areas cannot be known.

In the present study, traditional analysis were used in order to test the reliability and validity of HSOPSC. The combination of analysis used is not comprehensive when it comes to assessing the content validity of all concepts. Based on the researchers' experiences, the content validity of HSOPSC seems good with one exception: the outcome variable "Frequency of event reporting". Items included in this dimension concern mistakes made and reported; however, items are limited to any mistake that "is caught and corrected before affecting the patient", "has no potential to harm the patient", and "could harm the patient". In other words, this dimension measures something more limited than a broader frequency of event reporting — namely, the reporting of near misses. Based on these arguments "Frequency of no harm reporting" is probably a more suitable name for this dimension.

Implications and conclusions

The current study's results demonstrated that the factorial structure of HSOPSC was replicated at a Norwegian hospital, and results generally complied with conventional reliability and validity criteria. The examination of new measures in independent samples is important (Stone, 1978) as it gives further evidence for the psychometric properties of measures. Based on this study, the general impression is that the factorial structure of HSOPSC can be generalized and HSOPSC is usable in a Norwegian hospital context.

One dimension showed to have weaker internal consistency: "Organizational learning — continuous improvement" (.51). Based on results from the CFA and the low alpha score, practitioners and researchers should consider removing the item "mistakes have led to positive changes here"; however, practitioners and researchers should also be aware that removing an item will reduce the possibility for exact comparison with benchmark data. The ten safety culture dimensions were less strongly related to the outcome dimensions "Number of events reported (last 12 months)" and "Frequency of event reporting". The "Patient safety grade" and "Overall perceptions of patient safety" seem to be the most valid outcome measures of HSOPSC.

This work has been part of a PhD thesis and the aim of the present study was to translate and test the validity and reliability of the Hospital Survey on Patient Safety Culture in Norwegian health care. In order to achieve this aim, applying all relevant methods are challenging; however, it is important to do so in order to make correct scientific conclusions and avoid Type I and Type II errors. Other researchers should also be aware of the difficulty of achieving high response rates among hospital staff,

which we consider to be the most practical challenge after conducting this study. Future research should explore associations between HSOPSC dimensions and other organizational outcomes in health care settings, combining studies with other methods. Another important research task will be to conduct longitudinal studies (Carroll, 1998). Longitudinal studies will give answers to the stability and changeability of safety culture. Also, by using longitudinal designs researchers can investigate which interventions most effectively improve the levels of safety culture in health care settings.

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