ORIGINAL ARTICLE

The Relationship between Patient Safety Climate and Medical Error Reporting Rate among Iranian Hospitals Using a Structural Equation Modeling

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Citation: Mostefa Shahabinejad, Hadi Khoshab, Kazem Najafr, Aboutalem Haghshenas. The Relationship between Patient Safety Climate and Medical Error Reporting Rate among Iranian Hospitals Using a Structural Equation Modeling. Ethiop J Health Sci. 2020;30(3):319.doi:http://dx.doi.org/10.4314/ejhs.v30 i3.2
Received: November 11, 2019
Accepted: December 23, 2019
Published: May 1, 2020

Funding: Nil
Competing Interests: The authors declare that this manuscript was approved by all authors in its form and that no competing interest exists.
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ABSTRACT

***BACKGROUND:** Improving patient safety is a global health imperative, and patient safety climate is one of the components one that plays an important role in promoting patient safety. Medical error reporting is a way through which it can be evaluated and prevented in the future. The aim of this study was to assess the relationship between patient safety climate and medical error reporting in military and civilian hospitals.*

***METHODS:** This research was conducted by using structural equation modeling in the selected hospitals of Iran in 2018. The study community consisted of 200 nurses in the military and 400 nurses in the civilian hospitals. By using Structural Equation Modeling, the relationship between patient safety climate and the rate of medical error reporting in the hospitals was measured by a questionnaire. Data was analyzed using SPSS 17 and LISREL 8.8 software.*

***RESULTS:** The mean score of patient safety climate was moderate in the hospitals. There was no significant relationship between the rate of medical error reporting and patient safety climate, while a significant difference was found between patient safety climate score and age, sex, job category, and type of hospital ($P < 0.05$).*

***CONCLUSION:** The results suggested that patient safety climate and the rate of reporting errors were not favorable in the studied hospitals, while there was a difference between safety climate dimensions.*

***KEYWORDS:** Patient Safety Climate, Medical Error, Error Reporting, Structural Equation Model, Iran*

INTRODUCTION

Patient safety as a major cause of healthcare quality is meant to avoid causing injury to the patient during healthcare provision (1). Due to the increased injuries of hospitalized patients, the idea that healthcare systems are not secure enough and are in need of improvement has been taken into consideration increasingly (1,2). A review of studies showed that many patients receiving care in hospitals face complications or injuries arising from the provision of treatment

DOI: http://dx.doi.org/10.4314/ejhs.v30i3.2

services and a problem is added to an already existing problem (2). In order to increase the safety of hospitalized patients, adequate knowledge of the factors affecting it should be obtained (3). One of the components that plays an important role in improving patient safety in hospitals is patient safety climate (PSC) which refers to a perceived level of patient safety in a particular time and place (4). Safety climate is a psychological phenomenon and a subset of safety culture describing the staff's common perceptions of how to manage safety in the workplace at a particular time period (5). Safety climate demonstrates the employees' perceptions of patient safety situation in a given time period, which is associated with environmental and conditional factors subject to the existing circumstances (6,7). Results show that hospitals with a better safety climate have better service qualities and a lower incidence of errors (8).

Providing health services in medical centers is associated with risks to the recipients as a result of Medical Errors (MEs) (9). American Institute of Medicine has defined ME as a failure to fully implement the planned measures for use or a wrong approach to achieve a goal (10). It is estimated that 5-10% of health costs are generated by non-secure clinical services causing patient injury. MEs have significant clinical and economic implications affecting mortality indices in medical centers (11). Research has shown that 3-17% of patients admitted to hospitals suffer from side effects related to an unwanted event or ME in some way (10). Today's figures show that ME and adverse events annually, lead to the deaths of 210,000 to 440,000 people and more than 1,000,000 injuries. Many of these errors can be prevented by implementing well-known solutions in various researches (12).

A suitable PSC in a unit reduces errors and their harmful effects in hospitals. Therefore, reinforcement of safety climate has been recognized as a strategy to improve patient safety (13). Nowadays, the effects of proactive indices such as strengthening PSC and observing behaviors that emphasize current safety issues, on the reaction indicators such as frequency and ease of error reporting are considered by clinical staff (7). Combining these two preventive and reactive approaches can contribute to the achievement of the effects of the implementation of patient safety programs in hospitals (14).

Due to the extensive ME in health systems and costs associated with them, different methods have been designed for the management and prevention of them. One way to improve patient safety is reporting and recording MEs (15). Since nurses are the medical team members and are responsible for providing qualitative healthcare to patients (16), reporting their errors can improve the quality of care (17). The culture of reporting failures and errors is considered as a prerequisite for learning culture which will be achieved when a non-punitive environment after reporting errors dominates hospitals (18). Rasmussen's study results indicated that a poor PSC is significantly associated with the incidence of adverse events and nurses are reluctant to report their errors (19). The results of many studies have shown that strengthening PSC leads to a reduction in ME and adverse events in treatment centers (5-20)

The increasing number of MEs and increase of people's attention and pressure on public opinions on this issue as well as the importance of patient safety necessitated this research to measure the relationship between PSC and reporting ME in hospitals using Structural Equation Modeling (SEM). The results of this study can contribute to the identification of strengths and weaknesses of safety issues in hospitals by policy makers and healthcare managers to provide effective strategies for improving patient safety and quality of care.

METHODS

This cross-sectional study was conducted in the selected hospitals of Iran through SEM in 2018. The study population consisted of nurses in all the military and civilian hospitals of Kerman, Iran (eleven hospitals). The hospitals and nurses of different departments were selected via stratified and random sampling methods, respectively. Within the study community, based on SEM and using the principles of determining the sample size in multivariate regression analysis, the following formula was used (21,22): $5q \leq n \leq 15q$- Where q is the number of items in the questionnaire and n is the sample size. A total sample size of 600 subjects was calculated. In proportion to the number of nurses employed in each hospital, 400 persons were

DOI: http://dx.doi.org/10.4314/ejhs.v30i3.2

selected from civilian hospitals and 200 persons were selected from military hospitals.

The inclusion criterion for the nurses in the study hospitals was having at least one year of experience. The sampling process determined the number of samples in each center after specifying the selected civilian and military hospitals in terms of the number of nurses working in each hospital. Then, during different visits, the qualified nurses who had the necessary criterion and willingness to participate in the project were randomly selected and participated in the research from all the healthcare sections in different shifts.

For assessing safety climate, a researcher-made questionnaire of PSC was employed in Persian language, which was based on the kudo, SCS and PSCHO questionnaires (21-23). The questionnaire has 3 parts: the first part contains nine questions which are related to the demographic characteristics of the participants. The second part includes forty questions which are related to safety climate assessment. The last part has five questions which are related to ME reporting. A five-item Likert scale was considered for responses. The scores 5, 4, 3, 2 and 1 were regarded for strong agreement, agreement, neither agreement nor disagreement, disagreement and quite disagree, respectively. For determining the questionnaire's validity, 10 professors and experts in the field of patient safety were employed and for checking reliability Cronbach's alpha was calculated (α=0.931). The questionnaires were distributed in the mentioned hospitals in different shifts after confirming the nurses' informed consents and observing all the ethical considerations.

Data analysis: The benchmark for data analysis was factor analysis and for interpreting and identifying factors, varimax rotation method was utilized. Besides descriptive and inferential statistics, the dimensions of safety climate were identified using exploratory factor analysis. Then, using confirmatory factor analysis based on SEM, the conceptual model was designed, presented and approved by performing confirmatory factor analysis for several times. To fit the model, NFI, NNFI, NFI, GFI, AGFI, IFI, and RMSEA indicators were applied. Also, according to the study objectives, descriptive statistics, ANOVA and t-test were used, SEM analysis was conducted with the help of SPSS 17 and LISREL 8.8 software.

RESULTS

From the 600 distributed questionnaires, 532 were used in this study (response rate 88.7%). The mean age of the participants was 31.49 ± 5.84. 73.9% were female and 73.5% of them were married (Table 1).

Table 1: Demographic characteristics of the participants (n = 532).

Demographic characteristics		Frequency	%
Gender	Male	139	26.1
	Female	393	73.9
Marital Status	Married	391	73.5
Type of Hospital	Military	180	33.8
	Civilian	352	66.2
Employment Status	Formal employment	210	39.5
	Passing a project	49	9.2
	Conscript	14	2.6
Job Category	Head nurse	49	9.2
	Technician	38	7.1
	Paramedic	70	13.2
Education Degree	Paramedic diploma	63	11.8
	B.Sc.	14	2.6
	M.Sc.	21	3.9
Health sector	Surgery Department	108	20.3
	Department of Internal Medicine	62	11.7
	ICU	71	13.3
	Neonatal ward	36	6.7
	Maternity ward	28	5.3
	Psychiatry Department	27	5.1

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At first, 40 latent variables or factors were used for factor analysis. Using exploratory factor analysis, the factors (latent variables) were identified. In other words, the data were summarized in a smaller set of factors. In fact, exploratory factor analysis aimed at reducing the data and identifying the structure. For the exploratory factor analysis, it was first ensured that the data could be applied for analysis. Using Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) test, the sampling adequacy was guaranteed. By finding the value of KMO equal to 0.90, it was determined that the existing correlations between the data were suitable for factor analysis and there was a sampling adequacy for exploratory factor analysis. To ensure the appropriateness of the data, in that, the correlation matrices that make the basis for analysis are not equal to zero, Bartlett's test was also utilized. Since the significance level of Bartlett's statistic is equal to zero and less than 0.05, the assumption of zero was rejected and that of one was confirmed. This means that the data structure was appropriate for carrying out the exploratory factor analysis.

By conducting the exploratory factor analysis, the factors were reduced to 34 and 36 cases in the military and civilian hospitals, respectively, and by performing the confirmatory factor analysis, it was determined that the desired questions were of a good explanatory power, that is, the extracted indicators were of the necessary validity. After the completion of the exploratory and confirmatory factor analyses, 9 dimensions were derived to measure PSC. These dimensions included management support for patient safety, workload, supervisors' attitudes, error reporting, error management, communications, employees' empowerment, teamwork, and quality and safety of medical care.

PSC had a minimum and maximum range of 34 and 170 scores in the military hospitals. The score ranges of 34-79, 80-125 and 126-170 were considered as poor, average and good safety climates, respectively. The resulting score was calculated from the PSC to be 110.40 in the military hospitals. In the civilian hospitals, safety climate had the minimum and maximum range of scores, 36 and 180, and the scores ranging from 36-84, 85-132 and 133-180 were regarded as poor, average and good safety climates, respectively. The PSC score calculated was 115.07 for civilian hospitals. In general, PSC scores of civilian and military hospitals were moderate.

Comparison of PSC scores based on demographic characteristics of the study participants was indicative of a significant difference between PSC score and age (P=0.002), gender (P=0.001), job category (P=0.001) and hospital type (P=0.001). There was a significant relationship between the reporting errors and hospital type (P=0.001) and job category (P=0.003).

According to the nursing personnel's assertion, the incidence rate of errors during the summer quarter of 2018 was 69.6, of which 42.9% were reported, while the total error reporting rate in proportion to the frequency of the errors that occurred was 61.63% (Diagram 1).

DOI: http://dx.doi.org/10.4314/ejhs.v30i3.2

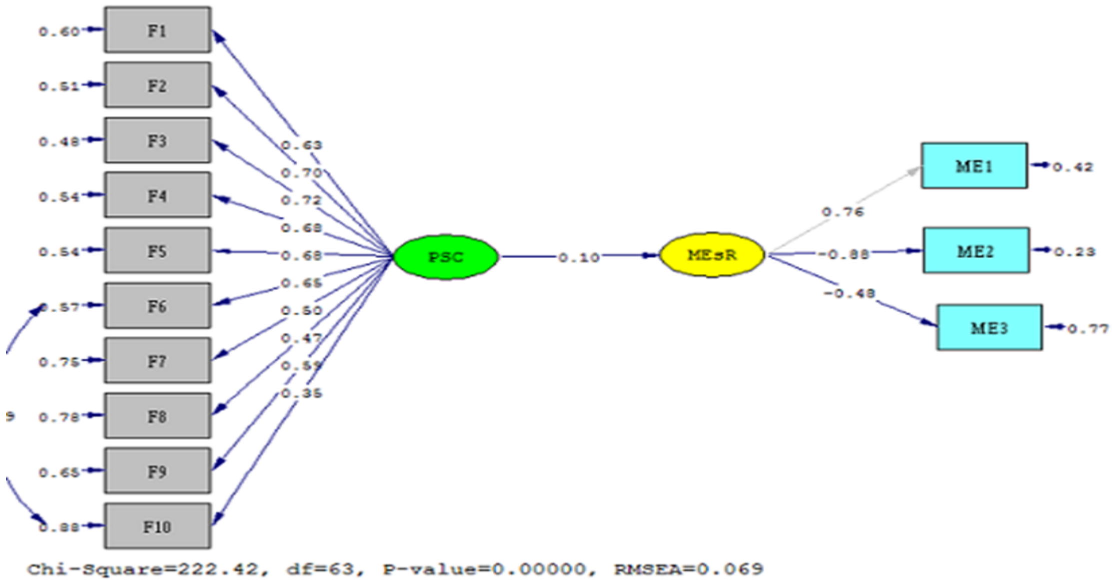

Figure 1*: Standard estimate model of the relationship between patient safety climate and medical error reporting using structural equations*

Finally, after designing of the structural model and since the relationship between the structure and dimension in the standard estimate model is higher than 0.45, it can be said that the desired questions have a good explanatory power, so the derived indices have the necessary validity (Figure 1). In the model of numbers, the validity of the measurement structures of the relevant variables was confirmed at a significance level of 0.05 (T-value) considering the fact that all the parameters of the model were higher than the absolute value of 1.96, except for the relationship between PSC and reporting ME. Since the parameters related to PSC and ME reporting were less than the absolute value of 1.96, no significant relationship was observed between them in the studied hospitals (Figure 2).

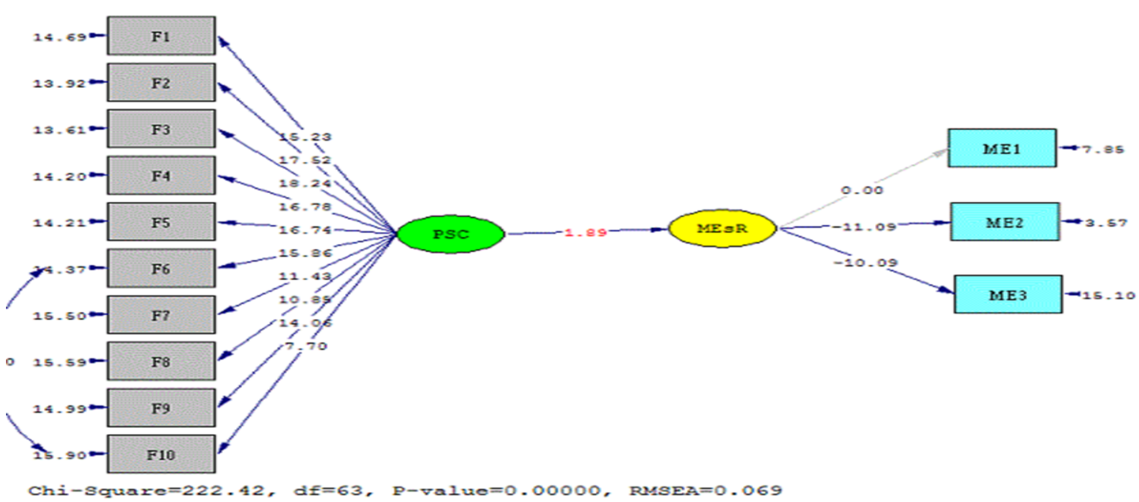

Figure 2*: The numerical model relevant to the significance of the relationship between patient safety climate and medical error reporting using structural equation*s

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Several indicators were used to fit the model. It was found that the model had a good fit and it could be concluded that it had good accuracy and fitness for analyzing the structural relationship between PSC and medical error reporting (Table 2).

Figure 3*: Incidence rates and error reporting in the hospitals*

Table 2: Fitness indices for the structural equation model

Index	RMSEA	(x^2/df)	GFI	AGFI	NFI	NNFI	CFI	IFI
Acceptance threshold	0.8>	3>	0.9<	0.9<	0.9<	0.9<	0.9<	**0.9<**
Value	0.69	3.53	0.94	0.91	0.94	0.95	0.96	**0.96**

DISCUSSION

According to the mean and range of safety climate score, the safety climate in the study hospitals was moderate. This finding is consistent with the results of Noohi et al. in Iran. They found the mean and standard deviation of safety climate score at a moderate level too (66 ± 10) (24).

In the military hospitals, the averages of maximum and minimum dimensions of safety climate were related to management support from patient safety (22.63), and communications (6.93), respectively, while in the civilian hospitals, the highest and lowest averages of safety climate dimensions were related to management support from patient safety (20.89), and quality of medical care (7.58), respectively. In this regard, the results of Moghnibashi et al.'s study showed that the total average safety climate in rehabilitation centers is moderate and the highest and lowest averages of safety climate dimensions are related to "management commitment to safety" and "employees' awareness of safety issues", respectively (25). Also, the results of Zhou's study in general hospitals in China revealed that the employees' impressions of PSC are relatively positive, while the dimensions of "fear of blame" and "fear of shame" had the highest points among the staff of the hospitals (26).

Additionally, the results of Nicolaides and Dimova's study, which evaluated PSC based on 6 dimensions, showed that the maximum and minimum scores were related to job satisfaction and stress detection, respectively. Also, a robust inverse correlation was found between labor intensity and employees' overall impressions of safety climate (-0.72) (27). The results of Chakravarty's investigation on the hospitals in India showed no difference between patient safety index scores. However, there were significant differences between the different groups of health workers in all aspects of "teamwork", "management perception" and "understanding of stress" ($P<0.05$) (28). The results of all these studies indicated that, in addition to the demographic characteristics, many side factors are effective in the PSC in treatment centers.

The results of the current study demonstrated that safety climate score varies between hospitals and the various departments of a hospital. The average scores of safety climate for

DOI: http://dx.doi.org/10.4314/ejhs.v30i3.2

military hospitals were lower as compared to those of the civilian hospitals, and safety climate had the lowest score within the internal departments. This could be due to a special atmosphere governing military hospitals in Iran, which defines working relationships among employees in specific frameworks. The study of Ausserhofer et al. in Switzerland also showed that nurses' perceptions of PSC were different in different departments and in different hospitals (29). In the mentioned study, the personnel of emergency departments, in which patients are at greater risk of adverse events, were found to have poorer understanding of safety climate as compared to those of the other departments. This suggests that even at the same health center, staff from different wards can have a different understanding of the patient's safety, and this indicates the impact of the nature of the treatment on PSC. However, Kristensen's study on Danish hospitals showed no significant differences between PSC and nurses, doctors and their ages, genders and work experiences (P>0.05) (30). In their research, the different perceptions of PSC were observed among the staff of the same department rather than in various departments and different hospitals.

Comparison of PSC scores based on demographic characteristics of the participants showed a significant relationship between PSC score and age, gender, job category and hospital type. These findings are not compatible with the results of Mahfuzpour et al.'s research (31). In their study, a significant relationship was found between attitudes and work experience (P<0.05), but not gender (p=0.13), marital status (p=0.45) and organizational positions of the participants (p=0.52).

In military hospitals, nurses had a poor understanding of communication dimension. The findings of different studies have shown that communication is an essential part of medical activities, and is accounted an important factor in the prevention of patient safety risks (4). Ineffective communication between professions and problems in communication has been one of the most important causes of adverse events and preventable problems in healthcare (7). The study of Kudo et al. on Japanese nurses further revealed that from the perspective of nurses, communication with physicians in providing patient safety is effective and nurses know it is an important factor in reporting and preventing their errors (32). In Khoshab et al.'s study, they revealed lack of effective communication in the team is an impediment to the care of patients (7).

The mean score of the medical care quality dimension was the lowest in civilian hospitals. Since a positive safety climate reduces ME and poor safety climate decreases the quality of healthcare (33), the managers must apply appropriate policies to provide enhanced PSC. Although military hospitals as compared to civilian hospitals gained a lower safety climate score, the reporting rate of errors that occurred was higher in military hospitals, which could explain lack of correlation between the PSC and reporting the ME in the study hospitals. Of course, there are reasons for failure to report the errors. The results of the study conducted by Shahabinejad et al. in police hospitals showed that barriers for reporting errors were related to fear of the consequences of reporting them, administrative factors, reporting processes and ethical factors (34). In this regard, Zaboli et al. categorized these barriers into 5 areas in their research, which include management factors, reporting outcomes, ethical factors, reporting processes and environmental factors (35).

In the developing countries, in the absence of error tracking systems in medical centers, promoting voluntary error reporting culture is essential to enhance patient safety (36). Vural's study in this field demonstrated that most unfortunate events are related to failures of different systems at the hospital, not to individual actions, while voluntary reporting of ME is greatly associated with getting appropriate feedback on performance after error reporting and finding communication channels to discuss patient safety (37). Also, the results of Moody's study in America revealed that the presence of proper safety climate, open communication and staff motivation are the factors that facilitate error reporting among nurses (38).

The results revealed that PSC was not optimal in the studied hospitals, and there was a difference between safety climate dimensions in various hospitals. Despite the clinical staff's

DOI: http://dx.doi.org/10.4314/ejhs.v30i3.2

acknowledgement that ME should be reported, the rate of reporting errors in studied hospitals was not desirable. Military and civilian hospital managers must apply appropriate policies to encourage staff to report their own errors; otherwise, staff reluctance to report their errors would increase and affect patient safety quality. Management of the reported errors is an effective factor in favor of a voluntary error reporting system in civilian and military hospitals. Managers should take appropriate measures to provide a situation, in which staff believe that reporting errors will cause positive changes in the system rather than embarrassing them and being punished.

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