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Patient safety climate and the intervention of the quality control circles: An empirical study at a general hospital in Taiwan

Shao-Jen Weng[a]
Seung-Hwan Kim[b†]
Chieh-Liang Wu[c]
Shih-Chia Liu[d]
Ying-Ye Jiang[e]
Kuei-Fen Yang[f]
Donald Gotcher[g]
Yao-Te Tsai[h]

[a,d]*Department of Industrial Engineering and Enterprise Information, Tunghai Univeristy, Taichung City 407, Taiwan.*
[b]*School of Business, Embry-Riddle Aeronautical University, Prescott, AZ 86301, U.S.A.*
[c]*Department of Critical Care Medicine, Taichung Veterans General Hospital, Taichung City 407, Taiwan.*
[e,f]*Center for Quality Management, Taichung Veterans General Hospital, Taichung City 407, Taiwan.*
[g]*Department of International Business, Tunghai University, Taichung City 407, Taiwan.*
[h]*National Kaohsiung University of Science and Technology, Kaohsiung, Taiwan.*

† kims115@erau.edu *(Corresponding author)*

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ABSTRACT
Quality Control Circles (QCCs) were instituted. Through the use of the Safety Attitudes Questionnaire (SAQ), we aimed to demonstrate a correlation between QCCs and improvements in units' Patient Safety Culture (PSC). This study utilized data collected by SAQs at Taichung Veterans General Hospital (TCVGH) in Taiwan. We investigated the relationships among the levels of units' QCC participation and the dimensions of SAQs through methods such as latent class analysis (LCA) and generalized estimating equations (GEE). Approximately 30 QCC teams from 78 units (wards or divisions) participate annually. The participation of teams in QCCs is classified into "low," "medium," and "high" levels by LCA. Results indicate that higher QCC participation correlates with a greater reduction in performance on the dimension of "Job Satisfaction"; specifically, the performance scores for medium and high participation are 2.34 points and 2.83 points lower than those for low participation. Despite the reduction in "Job Satisfaction," members in the high participation group continue to prioritize patient safety and demonstrate stronger stress resistance. Regarding quality improvement promoted through QCCs, units with higher participation should emphasize patient safety more. However, authorities need to pay increased attention to opinion acceptance and adoption, as well as employee well-being during the operation process.

Contribution/Originality: The paper's primary contribution is to find the relationship between Quality Control Circle participation and Patient Safety Culture in a Taiwanese hospital using Safety Attitudes Questionnaires. It applies latent class analysis and generalized estimating equations to reveal nuanced effects, highlighting both positive cultural impacts and challenges in job satisfaction.

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1. INTRODUCTION
Quality control circles (QCCs), first established in Japan in 1962, have been widely used in medical and healthcare fields in Germany, Austria, and Thailand. In practice, they are small groups of 6 to 12 professionals from

similar backgrounds who meet at regular intervals to discuss and review their clinical activities (Rohrbasser, Mickan, & Harris, 2013).

Quality control circles (QCCs) are well established as a means of aiding doctors (Schneider et al., 2008). Quality Control Circles (QCCs) are organized by personnel from similar, identical, or complementary fields (Chen et al., 2016). The team implements brainstorming and cooperation activities according to corresponding programs. They use statistical tools and quality control measures scientifically and flexibly to solve problems and topics related to work field culture and proper management (Khanehmasjedi, Miresmaili, Jafari, & Khanehmasjedi, 2017). They are an important link in comprehensive quality management, requiring the participation of the entire staff. They realize the goals of self- and mutual enlightenment through the flexible use of various quality-control means. Thus, they can be used for the maintenance and improvement of activities and jobs (Zhang, Tang, & Ying, 2018).

Numerous studies suggest that QCCs improve individual and group performance in terms of costs, ordering of tests, prescription habits, and adherence to clinical practice guidelines, thus resulting in better patient outcome measures and changes in performance indicators (Rohrbasser et al., 2013). QCCs have proven to be effective in disparate areas such as drug prescriptions and expenditures, ambulatory care, asthma care, pain management, primary care, and antimicrobial resistance and infection control (Chen et al., 2016; Gerlach, Beyer, & Römer, 1998; Riou, Piette, Durand, & Chaperon, 2007; Schneider et al., 2008; Zhang et al., 2018).

In instituting QCCs, managers must consciously provide an environment that facilitates employees' collective efforts in improving their work systems. If the leader is supportive, coaching-oriented, and has non-defensive responses to questions and challenges, members are likely to conclude that the team constitutes a safe environment (Edmondson, 1999). Creating a safety culture involves moving away from the traditional approach of "naming, shaming, and blaming" to one that encourages and supports shared reporting of errors openly in a non-punitive, positive environment (Stock, McFadden, & Gowen III, 2007). Small group participants take part in a variety of exercises that identify risks, define goals, and measure progress. The intent is to foster an environment where individuals feel comfortable discussing errors, and then information and knowledge are shared freely.

We expect that organizational culture plays a critical role in the success or failure of reducing medical errors in hospitals. Stock et al. (2007) described how "safety culture is a critical element necessary to achieve reductions in medical errors and adverse events" (Stock et al., 2007). It is also important to understand that most health care organizations will require a conscious effort on the part of managers to change the existing culture to one that focuses on patient safety (Ruchlin, Dubbs, Callahan, & Fosina, 2004).

Safety Attitude Questionnaires (SAQ) are incorporated in an effort to provide a systematic review of PSC with regard to aspects such as organizational factors, work environment factors, team factors, and personnel factors. The purpose of the SAQ is to illustrate the feelings within the work environment (Patterson, Huang, Fairbanks, & Wang, 2010). These feelings can be captured in a number of dimensions, including stress recognition, team climate, safety climate, job satisfaction, perception of management, and working conditions. Analysis of the SAQs can have a significant impact on participation in and compliance with the PSC. Without such participation and compliance, poor safety, ineffective communication, static change, and lack of comprehensive improvement can result (Mascherek & Schwappach, 2017; Sexton et al., 2006).

In this paper, the monitoring and modification dimensions implicit in QCCs are instituted through the use of the Safety Attitudes Questionnaire (SAQ) survey in an effort to show a correlation between QCCs and units' improvement in Patient Safety Culture (PSC). Quarterly SAQs were conducted as part of QCCs at Taichung Veterans General Hospital in Taiwan to derive annual total scores and rankings of medical care teams.

2. RESEARCH METHODOLOGY

The Safety Attitudes Questionnaire (SAQ) of Taichung Veterans General Hospital was used as the data source for the survey. For privacy protection, the study was approved by the Institutional Review Board (IRB) of Taichung Veterans General Hospital (IRB No.: TCVGH No. CW17045A).

The Chinese version of the Safety Attitude Questionnaire (SAQ), which includes six dimensions team climate, safety climate, job satisfaction, stress recognition, perception of management, and working conditions was developed to assess hospital safety culture in Taiwan. A hospital-wide patient safety culture (PSC) survey using the SAQ was conducted annually in November. Each item was scored by converting responses from a 5-point Likert scale to a 100-point scale: 1 = 0, 2 = 25, 3 = 50, 4 = 75, and 5 = 100.

Taichung Veterans General Hospital conducts a Quality Control Circle (QCC) activity aimed at improving lean healthcare, team resource management, process regeneration, patient safety, quality promotion, information technology, and customer value orientation. The quality management center assigns counselors for guidance, and in-hospital follow-ups are held, including evaluations of team composition, operation, promotion process, and goal setting. Effectiveness tracking and final results are horizontally expanded to achieve the ultimate goal of maintaining patient safety. Most QCC activities are carried out within medical departments. The 14 administrative departments—social work, nutrition, general affairs, occupational safety and health, accounting and statistics, information, medical affairs, personnel, civil service ethics, supplies, engineering affairs, clinical information center, medical education, and research—are excluded from the survey regarding the correlation between QCC and patient safety culture (PSC). QCCs serve as a bottom-up tool for quality improvement. Most teams report progress through increased self-inspiration, self-confidence, team cooperation, and a sense of responsibility and accountability following QCC activities. Annually, approximately 30 QCC teams are formed from 78 units, including wards and divisions. This study aims to evaluate whether the patient safety climate of these groups improved after implementing QCCs.

Latent class analysis (LCA) is a method for categorizing individuals who perform similarly in indicator patterns within the same subgroup of a population. LCA was applied in the present study to identify QCC participation patterns. The LCA model estimates item-response probabilities and class membership probabilities. In this study,

item-response probabilities describe the patterns of QCC participation used to measure the latent variable. Each latent class was named according to the item-response probabilities. Class membership probabilities represent the estimated prevalence of each class.

Moreover, the patient safety culture performance in past years is discussed according to LCA grouping, and the correlation between QCC participation and patient safety culture is analyzed and discussed with generalized estimating equations (GEE). All analyses were carried out using SAS version 9.4 (SAS Institute, Cary, NC, USA). The LCA models were fitted using an SAS procedure, PROC LCA version 1.3.2, developed by the Methodology Center, Pennsylvania State University.

3. RESULTS

Table 1 lists the answers of the PSC survey. The annual survey shows that more than 80% of respondents are female and approximately 60% are nursing personnel, followed by administrators at about 15%.

Table 1. Characteristics of participants in the SAQ survey.

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Sample size	2316	2277	2190	2576	2911	2944
Gender						
Male	437(18.9%)	378(16.6%)	345(15.8%)	445(17.3%)	564(19.4%)	622(21.1%)
Female	1879(81.1%)	1899(83.4%)	1845(84.2%)	2131(82.7%)	2347(80.6%)	2322(78.9%)
Occupation						
Physician	288(12.4%)	244(10.7%)	160(7.3%)	202(7.84%)	343(11.8%)	375(12.7%)
Nursing personnel	1288(55.6%)	1352(59.4%)	1440(65.8%)	1541(59.8%)	1627(55.9%)	1556(52.9%)
Medical technician	215(9.3%)	205(9.0%)	135(6.2%)	211(8.2%)	281(9.7%)	260(8.8%)
Pharmacy staff	63(2.7%)	63(2.8%)	55(2.5%)	80(3.1%)	90(3.1%)	91(3.1%)
Administrator	319(13.8%)	304(13.4%)	274(12.5%)	407(15.8%)	408(14.0%)	510(17.3%)
Rehabilitation staff	15(0.7%)	12(0.5%)	22(1.0%)	24(0.9%)	18(0.6%)	25(0.9%)
Others	128(5.5%)	97(4.3%)	104(4.7%)	111(4.3%)	144(4.9%)	127(4.3%)

According to the adjusted Bayesian Information Criterion (BIC) value of each fitted LCA model, we used the three-class model as the final model. In general, the smaller value of BIC represents a better model fit. The classes identified in the three-class model should represent heterogeneous QCC participation patterns sufficiently. The participation of teams in QCC is classified into "low," "medium," and "high" in this study. "Low" presents continuous low annual participation, "medium" denotes more participation than "low," but shows a decreasing trend annually, and "high" reveals high participation.

In regard to the participation situation, 45 departments had low participation, and most of them (29, 64.4%) were sub-departments that have never participated in QCC activity, while the remaining 16 departments with lower participation did so 1-3 times during the 6 years. Among 21 departments with medium participation, most of them (20 or 95.2%) participated 1-3 times. A total of 11 departments had a high participation frequency of 4-6 times. The largest number of low-participation groups were in medical departments (near 60%); 14 out of 21 medium-participation departments were nursing departments; and nursing departments participated at a higher percentage than medical departments. The characteristics of the units with low, medium, high QCC participation are presented in Table 2.

Table 2. Characteristics of the units with low, medium, high QCC participation.

	Low(n=45)		Medium(n=21)		High(n=11)	
	n	%	n	%	n	%
Number of QCCs						
0	29	64.4	0	0.0	0	0
1-3	16	35.6	20	95.2	0	0
4-6	0	0.0	1	4.8	11	100.0
Unit						
Nursing departments	16	35.6	14	66.7	8	72.7
Medical departments	27	60.0	8	33.3	0	0.0
Medical affairs departments	2	4.4	0	0.0	3	27.3

The mean scores of low-, medium-, and high-participation were 72.45, 66.60, and 67.48, respectively. The difference between high and low is about 6 points. However, QCC participation classification does not reveal remarkable statistical differences in patient safety culture according to the participation patterns. It is worth discussing that job satisfaction for QCC participation does not appear to show statistical differences, but different QCC participation levels show a trend of low participation but high scores. This is not the expected result in general practice experiences and is worth further investigation.

Furthermore, considering the correlation between the PSC trend and QCC in past years, the GEE method is used for analysis in this study. From Table 3, the participation in QCC shows negative effects on "Job satisfaction"; higher QCC participation reduces performance on the dimension. That is, taking low participation as the baseline, the performance of medium participation and high participation on the dimension appears 2.34 points and 2.83 points lower than low participation. According to the model results, medium participation and high participation present better scores on the rest of the dimensions than low participation; however, the performance on these dimensions does not reach significant statistical differences in QCC participation.

Table 3. Estimated coefficients of the GEE method for the PSC scores of each dimension.

	Dimension					
	Team Climate		**Safety Climate**		**Job Satisfaction**	
	Coef	**SE**	**Coef**	**SE**	**Coef**	**SE**
Intercept	70.44	1.52	72.41	0.94	71.96	1.29
[1]QCC participation						
Medium	0.82	2	0.36	1.5	-2.34	2.09
High	0.28	2.65	0.76	1.4	-2.83	1.98
	Dimension					
	Stress recognition		Perception of management		Working conditions	
	Coef	SE	Coef	SE	Coef	SE
Intercept	72.32	0.94	66.64	1.1	69.03	1.2
[1]QCC participation						
Medium	0.87	1.37	0.02	1.84	0.17	1.73
High	1.45	1.33	1.11	1.9	1.79	1.91

Note: [1]Low participation was used as the reference group.
Coef: Coefficient SE: Standard Error

On the other hand, it is considered that the wrestle among items in dimensions might be the reason that various dimensions do not show significance on QCC participation. For this reason, SAQ items are done using a difference analysis. Table 4 presents the dimensions with the significance smaller than 10%, including "Team climate," "Safety climate," "Job satisfaction," and "Stress recognition," a total of 5 items. Low QCC participation groups appear to have better performance on items 1 and 14 than high participation groups, with the mean scores of 69.14 and 72.48, respectively, where the difference in item 14 shows high significance ($p<0.05$).Furthermore, QCC participation reveals slightly better scores of those with good participation than those with low participation on items 2, 12, and 22, where item 12 shows higher significance difference ($p<0.05$).

Table 4. The score of the significant SAQ items ($p<0.10$) by different QCC participation groups.

Dimension	**Item**		**QCC participation**		
			Low	**Medium**	**High**
Team climate	1.	Nurse input is well-received in this clinical area. *	69.14	65.45	66.21
	2.	In this clinical area, it is difficult to speak up if I perceive a problem with patient care. *	64.17	68.96	67.13
Safety climate	12.	I am encouraged by my colleagues to report any patient safety concerns I may have. **	69.11	71.65	72.74
Job satisfaction	14.	I like my job. **	72.48	68.04	68.03
Stress recognition	22.	My work makes me feel exhausted. *	72.27	71.84	75.76

Note: *p-value<0.10; **p-value<0.05.

4. DISCUSSION

In the study, we found a trend of positive correlation between the levels of units' QCC participation and PSC, except in the dimension of job satisfaction. We have noticed that a few items have reached statistical significance among the low, medium, and high levels of QCC participation (Table 4). Overall, QCC participation might promote positive patient safety culture in units, except in relation to Job satisfaction.

Numerous studies indicate that Quality Control Circles (QCCs) enhance both individual and team performance by reducing costs, improving test ordering and prescription practices, and increasing adherence to clinical guidelines, ultimately leading to better patient outcomes and measurable improvements in performance indicators (Rohrbasser et al., 2013). However, to date, there are no data to confirm the effect of QCCs on a unit's PSC. Why are we unable to find a solid positive correlation between QCC participation and PSC? In the study design, we summed the PSC scores of all the unit members. However, the team members of QCCs were around 6-12, just a small portion of all units' members. Therefore, the positive impact of QCC participation might be compromised by the others without QCCs in their units. To clarify the effect of QCCs on individual PSC, a prospective study comparing the effects between those directly involved in QCC activities and those not involved is necessary. Our results demonstrated only the relationship between QCCs and PSC at a unit level.

QCCs select the issues they want to deal with themselves, decide on their method of gathering data, and determine a way of finding solutions to prioritized problems (Rohrbasser et al., 2013). Though the QCCs are run by a few team members, the activities of QCCs involve everyone in the unit. All the staff of the units have to help gather data and follow the new protocols proposed by the QCC team. On occasion, we observed negative responses to QCCs from non-QCC members, which even led to frustration among QCC team members. Conflicts among all unit members were observed. We must pay attention to the stress effects of QCCs on job satisfaction, which was negatively impacted by QCCs.

The research results reveal that higher participation in QCCs reduces the job satisfaction of members in the participation units. Moreover, those with distinct participation in quality control circles show positive cognition of patient safety culture regarding "Team climate," "Safety climate," "Job satisfaction," and "Stress recognition" (i.e., items 1, 2, 12, 14, and 22). For instance, when the items in quality control circles are task-oriented, the improvement effectiveness is apparent; that is, the burden falls on members in the process. Further, the research shows that such members in units with higher participation in quality control circles respond to problems in teamwork (items 1 and 2), exhibit lower identity with the work (item 14), but care about patient safety (item 12), and demonstrate stronger stress resistance (item 22). In other words, units with higher participation in quality control circles do not necessarily exhibit better job satisfaction; members regard the current working environment as unsatisfactory.

According to the findings from our previous study, perception of management leadership shows the largest effect on safety climate. Teamwork climate has the highest direct effect on safety climate (Weng, Kim, & Wu, 2017). Though QCCs are regarded as bottom-up activities, our leaders support the teams of QCCs. We have received many awards for the achievements of QCCs. It is implied that the perception of management has overcome the negative effects on job satisfaction and has maintained the positive trend of PSC. Through participation in QCCs and the analysis and discussion of PSC, the attitude of frontline core staff toward patient safety culture is understood in this study to promote healthcare quality and service standards. On the other hand, effective communication with teams (wards or divisions) could achieve consensus on patient care quality.

There are some limitations in this study. First, it is a retrospective study analyzing data from the past five years. However, the members of each unit are dynamic, with some members joining and others leaving, which may compromise the quality of responses to the SAQ. Second, we only categorized the units into low, medium, and high without considering the quality and achievements of QCCs.

5. CONCLUSION

As a matter of fact, the promotion of patient safety cannot simply rely on a department or a person; the support of managers in medical institutions and the continuous reinforcement of team communication and cooperation among healthcare members are the keys in driving the emphasis on patient safety and effectively promoting healthcare quality. In the quality improvement promoted in quality control circles, those with higher participation should stress more on patient safety. Moreover, the authority has to pay more attention to opinion acceptance and adoption as well as care about employees in the operation process. It is therefore suggested in this study to pay attention to the stress relief of healthcare members and the provision of multiple stress relief channels for related workers releasing certain emotions. Furthermore, the creation of a mutually supported team culture and the establishment of trusting interactive relationships could eliminate negative ideas and stress resulting from work.

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Institutional Review Board Statement: This study was approved by the Institutional Review Board of Taichung Veterans General Hospital, Taiwan under protocol number (IRB No.: TCVGH No. CW17045A). Informed verbal consent was obtained from all participants, and all data were anonymized to protect participant confidentiality.
Transparency: The authors state that the manuscript is honest, truthful, and transparent, that no key aspects of the investigation have been omitted, and that any differences from the study as planned have been clarified. This study followed all writing ethics.
Competing Interests: The authors declare that they have no competing interests.
Authors' Contributions: All authors contributed equally to the conception and design of the study. All authors have read and agreed to the published version of the manuscript.

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