Effectiveness of an In-Service Education Program to Improve Patient Safety Directed at Surgical Residents: A Randomized Controlled Trial

Ahmad Ameryoun, PhD,[*] Amir H. Pakpour, PhD,[†,‡] Mehdi Nikoobakht, MD,[§] Mohsen Saffari, PhD,[‖,¶] Mahdi Yaseri[#], Keisha-Gaye N. O'Garo, PsyD,[**] and Harold G. Koenig, MD[††,‡‡,§§]

[*]Health Management Research Center, Baqiyatallah University of Medical Sciences, Tehran, Iran; [†]Social Determinants of Health Research Center (SDH), Qazvin University of Medical Sciences, Qazvin, Iran; [‡]Department of Nursing, School of Health and Welfare, Jönköping University, Jönköping, Sweden; [§]Department of Neurosurgery, Iran University of Medical Sciences, Tehran, Iran; [‖]Health Research Center, Life Style Institute, Baqiyatallah University of Medical Sciences, Tehran, Iran; [¶]Health Education Department, Faculty of Health, Baqiyatallah University of Medical Sciences, Tehran, Iran; [#]Department of Epidemiology and Biostatistics, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran; [**]Department of Psychiatry and Behavioral Sciences, Duke University Medical Center, Durham, North Carolina; [††]Duke University Medical Center, Durham, North Carolina; [‡‡]King Abdulaziz University, Jeddah, Saudi Arabia; and [§§]Ningxia Medical University, Yinchuan, China

BACKGROUND: Patient safety is a critical issue in healthcare services particularly in surgical units and operation rooms because of the high prevalence and risk of medical errors in such settings. This study was conducted to determine whether a 1-day educational intervention can change the attitude and behavior of surgical residents regarding patient safety.

METHODS: A total of 90 surgical residents were recruited from 6 university hospitals located in Tehran and Qazvin, Iran, and were randomized to either the intervention or a control group. Those in the intervention group participated in a 1-day workshop on patient safety, whereas the control group received no intervention. Both groups were followed for 3 months after the intervention was completed. The Safety Attitude Questionnaire and Oxford Non-Technical Skills scale were administered at 3 points in time (baseline, 1 month after the intervention, and 3 month later). The data were analyzed using repeated measures analysis of variance.

RESULTS: Total score on the Safety Attitude Questionnaire improved from 54.5 (SD = 14.4) at baseline to 58.3 (SD = 13.8) 3 months after the intervention in the intervention group; all dimensions, with the exception of working condition, showed significant changes. In addition, the Oxford Non-Technical Skills scale — as assessed by attending surgeons — improved significantly in all domains ($p < 0.05$). More than 60% of participants in the intervention group scored in the positive range for items assessing safety and teamwork climate.

CONCLUSIONS: A 1-day interactive educational workshop may be effective in changing the attitude and practice of surgical residents regarding patient safety. Further assessment of this intervention in other healthcare settings involving health professionals from various specialties and use of an objective measure such as number of reported medical errors are needed to corroborate these findings. (J Surg Ed 000:1–10. © 2019 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

KEY WORDS: Patient safety, Education, Medical error, Nontechnical skills, Surgery

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Correspondence: Inquiries to Amir H. Pakpour, PhD, Social Determinants of Health Research Center (SDH), Qazvin University of Medical Sciences, Shahid Bahonar Blvd, Qazvin 3419759811, Iran; fax: (283) 323-9259; e-mail: Pakpour_Amir@yahoo.com

Correspondence: Inquiries to Mohsen Saffari, PhD, Health Research Center, Life Style Institute, Baqiyatallah University of Medical Sciences, Tehran, Iran; fax: (218) 248-3525.; e-mail: m.saffari@bmsu.ac.ir

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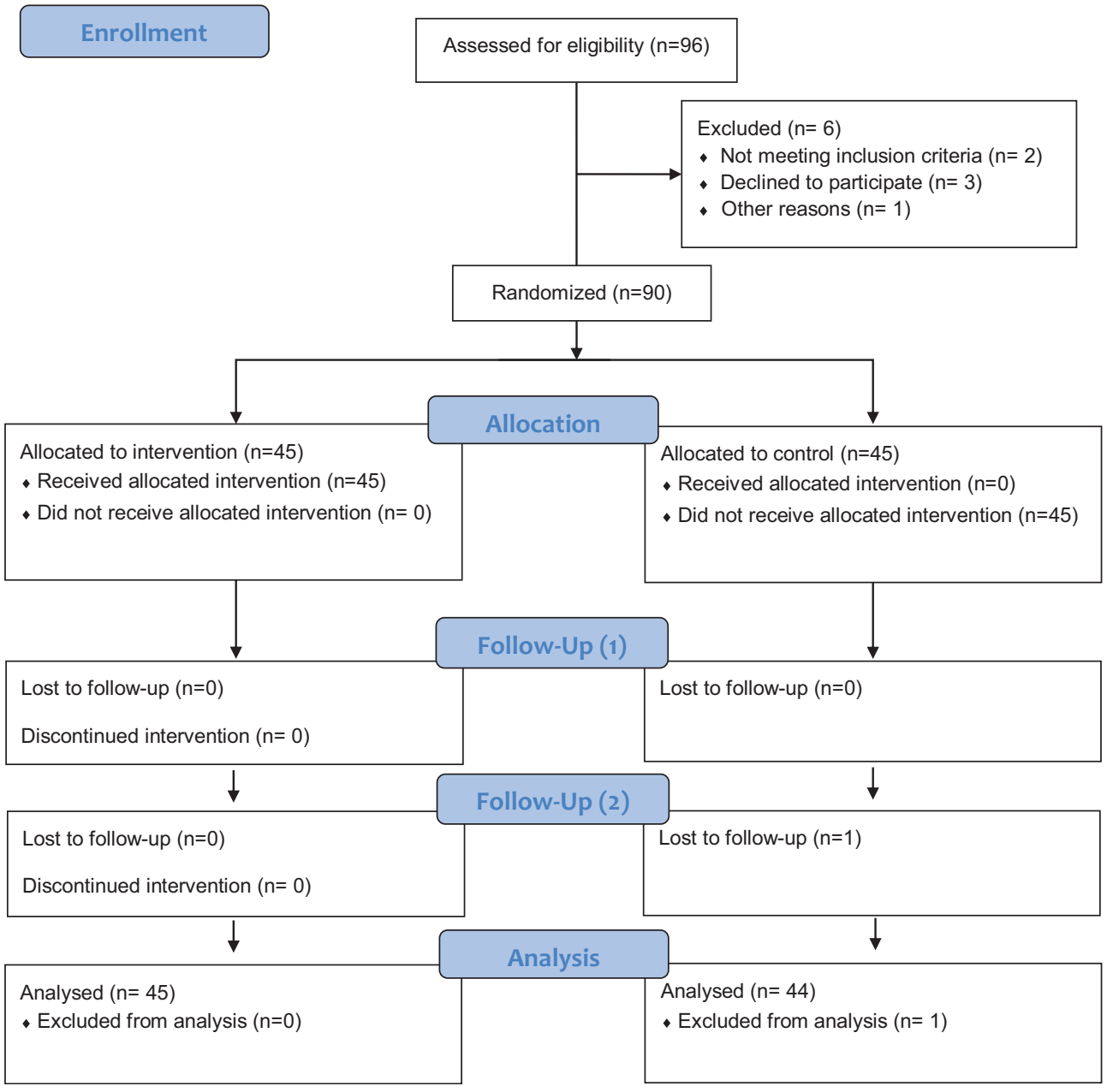

FIGURE 1. CONSORT flow diagram of the study.

INTRODUCTION

As healthcare providers learn to respect patient safety (PS), they will increasingly place a high priority on identifying sources of medical errors and finding corrective measures.[1] According to an Institute of Medicine report, it was estimated that about 100,000 deaths per year are attributed to medical errors in US hospitals. In 1999, there were 34,000,000 hospital admissions; 29 admitted patients per 10,000 died from medical errors.[2] In 2008, medical errors were responsible for nearly $20 billion in additional costs to the health system.[3,4] The negative impact of medical errors in developing countries such as Iran is unclear; however, research has found that countries in the eastern Mediterranean region suffer from high rates of medical errors. For each 100 to 150 patients admitted to Iranian hospitals, 1 patient dies from such errors.[5,6] Based on a recent estimate, more than 24,000 deaths per year could be attributed to medical errors in Iran.[7]

Factors such as lack of healthcare team collaboration, inadequate communication skills, low technical competency, high job stress, and poor working conditions have been recognized as primary factors associated with

medical errors.[8-10] Developing a culture of PS in hospital settings may help to reduce patient complications and adverse medical events. The high mortality and morbidity associated with medical errors underscore the need to make efforts to ensure PS in these environments.[11] Attention to PS is particularly important during the training of medical students, interns, and residents due to their limited experience and skill.[12]

Medical errors and preventable adverse events are common before, during, and after surgical operations and procedures.[13] In many academic medical centers, residents in training provide a significant amount of surgical and medical care to patients. Therefore, both attending surgeons and surgical residents need to be aware of the causes of medical/surgical errors and how to manage them.[14] Surgical residents are expected to have the technical and communication skills to provide quality medical care to patients.[15] Although in countries such as the United States and United Kingdom there is growing emphasis on training to avoid medical errors through communication and teamwork,[16,17] in developing countries like Iran, no standard curriculum exists on PS for health professionals in training, especially for those who may practice in environments at high risk for medical errors such as surgery. When encountering adverse events in such settings, health professionals in training often have insufficient knowledge and skill to handle these situations effectively. Therefore, it is essential for those in training to be involved in education programs to raise their awareness of these issues.

Unfortunately, few educational programs designed specifically for surgical residents exist that promote PS. Many programs focus on only a few elements of PS, whereas more comprehensive programs may be necessary. For example, in a randomized clinical trial of an educational intervention for surgical residents in the United States, only 3 components of PS were emphasized: safety culture, teamwork, and speaking up.[18] In another study that evaluated the same components, the authors concluded that the attitudes of surgical residents regarding PS are often unfavorable and there is an urgent need to improve such attitudes. In that study, perceptions of safety practice among surgical personnel including surgical residents were often poor and below that necessary for optimal patient care.[19] Since surgical residents spend long hours on duty during training and there is no established curriculum on PS, a brief educational workshop may be helpful in creating a positive shift in attitude and behavior among these health professionals. Because the first step in providing a culture of PS is to create such a shift in attitude and behavior,[1] the aim of the current study was develop and evaluate the efficacy of such an educational intervention.

METHODS

Sample and Procedures

Six academic general hospitals in Tehran and Qazvin, Iran were selected based on their accessibility for data collection. The study was carried out between February and June 2018. The total number of surgical residents in training at these hospitals was 103. Of the 96 residents approached, 3 declined to participate, 2 were ineligible, and 1 was not available at the beginning of the study. Therefore, 90 surgical residents agreed to and were available to participate in the study. Participants were randomized to intervention or control groups and followed up for 3 months after the intervention (Fig. 1). Sample size was calculated based on a formula suggested by Rosner to provide 80% power to compare 2 independent groups to detect a moderate effect size (0.60) at an alpha of 0.05. Inclusion criteria were surgical resident status for at least 3 months, having at least 6 months remaining in their training, and having no intention to move to another hospital during that 6-month period. Residents who participated in any PS program during the past 6 months or were guest residents from other institutions were excluded from the study. The study was approved by ethical committee of Qazvin University of Medical Sciences and all participants signed informed consents. To encourage participation, all subjects received a certificate of participation in the PS workshop (and for those randomized into the waitlist control group, a workshop was held after study completion). Two attending surgeons in each hospital were assigned to observe teamwork behaviors of residents throughout the study and rate them using the Oxford Non-Technical Skills (NOTECHS) scale (see section Measures). The attending physicians were blinded to treatment group.

Measures

Safety Attitudes Questionnaire

The original Safety Attitudes Questionnaire (SAQ) scale has 30 items that form the core of the scale and are included in all adapted versions for different healthcare settings. We used the core items provided by University of Texas. This version of the SAQ is comprised of 6 domains including teamwork climate (6 items), safety climate (7 items), job satisfaction (5 items), stress recognition (4 items), perception of management (5 items), and working conditions (4 items). Level of agreement with each item is on a 5-point Likert scale from 1 (strongly disagree) to 5 (strongly agree). The mean score for each domain is calculated by summing the scores for the items in that domain divided by number of items included in the domain. The total SAQ score is determined by summing the score means across all

6 domains. Higher scores indicate more positive perceptions for each domain or for the entire scale. Scores can also be converted to a percentage; the mean score of each domain is subtracted from 1 and the result is multiplied by 100. Using this method, summary scores range from 0 (worst attitude) to 100 (best attitude). When calculating percent of participants with a positive attitude for each subscale (i.e., have indicated slightly agree to strongly agree), scores of 75% or higher are considered an acceptable positive attitude.[20] A culturally adapted Persian version of the SAQ with acceptable psychometric properties was used in the present study.[21,22]

Oxford Non-Technical Skills Scale

The NOTECHS scale was developed to assess teamwork and communication quality in operating room with the purpose of identifying problems in this area. The scale includes four subscales that include leadership and management, teamwork and cooperation, problem solving and decision making, and situation awareness. The raters (attending surgeons), based on their observations of the particular health professional (surgical residents in this case), assign a score between 1 (below standard) to 4 (excellent). Each category is assessed based on behaviors observed by the rater. For example, to receive a high score in teamwork and cooperation, the surgical resident must demonstrate behaviors such as team building, support of others, understanding needs of other team members, and solving conflicts between team members.[23] This scale was translated from English to Persian using a forward-backward translation method together with language editing.

TABLE 1. Participant Demographics

Variables	Trial ($n = 45$) N (%)	Control ($n = 45$) N (%)	p Value
Age (year)			
<30	18 (40.0)	20 (44.4)	0.669
≥30	27 (60.0)	25 (55.6)	
Gender			
Male	28 (62.2)	24 (53.3)	0.393
Female	17 (37.8)	21 (46.7)	
Marital status			
Single	12 (26.7)	18 (40.0)	0.179
Married	33 (73.3)	27 (60.0)	
Prior education on PS			
Yes	22 (48.9)	15 (33.3)	0.133
No	23 (51.1)	30 (66.7)	
Postgraduate year			
1-3 (Junior)	28 (62.2)	26 (57.8)	0.666
4-5 (Senior)	17 (37.8)	19 (42.2)	

PS, patient safety.

Educational Intervention

The educational program in this study was based on constructs being measured by the SAQ. A 1-day workshop (8 hours) was developed with faculty members who were experts in surgery, health administration, health education, psychology, and nursing. First, a lecture provided the definition of PS, prevalence of medical errors, and consequences of medical errors, particularly the frequency in operating rooms. In this lecture, the concept and importance of PS were emphasized using practical examples. The expert panel then allowed participants to ask questions stimulated by the lecture. Next, participants gathered in small groups (7-8 member per group) to discuss communication problems and factors inhibiting effective communication between surgery staff, with a special emphasis on communication barriers between residents and operating room personnel. During the brain storming session that followed, all possible strategies to address communication issues in the surgery setting were listed and prioritized based on the views of the participants and those of the expert panel. Following that, a short movie was shown about how to use communication skills in a healthcare setting to communicate with colleagues and administrators to demonstrate appropriate relationships between staff with regard to how to identify and report medical errors. After that, a short introduction on job satisfaction and factors related to working conditions was provided and methods to improve working conditions and job satisfaction on the surgical ward were discussed. Next, coping skills were provided on how to deal with stressful events, as well as coping with fatigue, anger, workload, and unpredictable situations. These skills were taught by a psychologist and participants were asked to share their experiences regarding difficult conditions and how they managed them. Finally, a CD-ROM which included material presented in the workshop was provided to all participants, along with information on how to contact workshop faculty if further information or consultation was needed regarding specific situations that might arise.

Data Analysis

Quantitative data were presented as means (standard deviation) and categorical data were provided as number (percent). To compare demographics between intervention and control group, the chi-square test was used. The changes in attitude toward PS (SAQ) and scores on the NOTECHS were assessed using repeated measures analysis of variance. Normality of the outcome measures was assessed by Shapiro-Wilk test. The Mauchly test of sphericity was used to examine the similarity of variances of differences between groups. When this test is significant, the sphericity assumption is violated and an epsilon correction such as Greenhouse-Geisser or

TABLE 2. Patient Safety Attitude Component and Overall Scores (SAQ) in Study Participants at Baseline, 1-Month, and 3-Month Follow-Up

Component	Time 1		Time 2		Time 3		Within group comparison	
	Trial	Control	Trial	Control	Trial	Control	Trial	Control
Teamwork climate	65.3 (12.5)	64.1 (12.3)	71.6 (12.3)*	65.2 (12.5)*	69.2 (11.7)	64.5 (12.1)	T1 < T3 < T2	NS
Safety climate	64.3 (15.2)	64.7 (14.8)	72.8 (14.8)*	65.2 (14.6)*	70.9 (14.5)*	64.6 (14.7)*	T1 < T3 < T2	NS
Job satisfaction	58.3 (14.6)	58.7 (15.1)	61.2 (14.7)	58.1 (15.3)	60.1 (14.3)	56.8 (15.0)	T1 < T2, T1 < T3	NS
Stress recognition	45.3 (16.7)	44.6 (16.1)	53.2 (14.5)**	43.7 (16.3)**	52.1 (15.5)**	42.8 (15.8)**	T1 < T2, T1 < T3	NS
Perception of management	46.2 (13.5)	45.9 (13.8)	50.3 (12.8)	46.3 (13.5)	49.1 (13.2)	45.7 (13.4)	T1 < T3 < T2	NS
Working condition	47.9 (12.3)	47.1 (11.9)	48.5 (12.0)	46.8 (12.2)	48.1 (11.8)	46.5 (12.3)	NS	NS
Total score	54.5 (14.4)	54.2 (14.2)	59.6 (13.7)	54.2 (14.3)	58.3 (13.8)	53.5 (14.1)	T1 < T3 < T2	NS

NS, non-significant; * P< 0.05, ** P< 0.01.

Note. For between group comparison (trial vs control) in each time if there was a significant difference at p < 0.05, a single asterisk (*) has been inserted beside subscale values of both groups, and for a significant difference at p < 0.01, a double asterisk (**) has been applied.

TABLE 3. Non-Technical Skills (NOTECHS) Scores Assessed by Attending Physicians at Baseline, 1-Month and 3-Month Follow-Up in Intervention and Control Groups

Component	Time 1		Time 2		Time 3		Within-Group Comparison	
	Trial	Control	Trial	Control	Trial	Control	Trial	Control
Leadership and management	3.29 (0.48)	3.12 (0.52)	3.46 (0.45)**	3.15 (0.43)**	3.38 (0.46)*	3.16 (0.44)*	T1 < T3 < T2	NS
Teamwork and cooperation	3.12 (0.42)	3.08 (0.47)	3.35 (0.40)**	3.11 (0.45)**	3.32 (0.41)*	3.13 (0.44)*	T1 < T2, T1 < T3	NS
Problem solving and decision making	3.26 (0.52)	3.31 (0.55)	3.52 (0.48)*	3.30 (0.53)*	3.55 (0.44)*	3.34 (0.50)*	T1 < T2, T1 < T3	NS
Situation awareness	2.96 (0.58)	2.85 (0.61)	3.25 (0.51)**	2.91 (0.57)**	3.22 (0.47)**	2.88 (0.55)**	T1 < T2, T1 < T3	NS
Total score	3.16 (0.54)	3.10 (0.58)	3.40 (0.49)*	3.12 (0.53)*	3.37 (0.48)*	3.13 (0.52)*	T1 < T2, T1 < T3	NS

NS, non-significant; *p < 0.05; **p < 0.01.

Note. For between group comparison (trial vs control) in each time if there was a significant difference at p < 0.05, a single asterisk (*) has been inserted beside subscale values of both groups, and for a significant difference at p < 0.01, a double asterisk (**) has been applied.

FIGURE 2. Change in patient safety attitude components over time in intervention and control groups based on percentage of positive responses (agree slightly to agree strongly). Time 1, baseline; Time 2, 1 month after intervention, Time 3, 3 months after intervention; A, intervention group; B, control group.

Huynh-Feldt should be reported. For small samples, the Greenhouse-Geisser is more appropriate. The homogeneity of variances for between-group factors was assessed using Leven test of equality of error variances. When this test is not significant, there is no substantial difference between the variances and therefore the homoscedasticity assumption is established. The alpha level for all statistical analysis was set at $p < 0.05$. Analyses were performed using IBM statistics version 20 for Windows.

RESULTS

The mean age of participants was 32.8 (SD, 4.6) and majority (58%) were male. One-third to one-half reported they had already received education regarding PS. The number of junior residents (between years 1 and 3 postgraduation) among participants was approximately same as the number of senior residents (years of 4 and 5). There was no significant difference between participants in the intervention and control groups in term of demographic characteristics (Table 1).

Table 2 displays the total SAQ and subscale scores at baseline (Time 1), 1 month after the intervention (Time 2), and 3 months after the intervention (Time 3). The total SAQ score and all subscale scores (except working condition) changed significantly over time in the intervention group, while there was no substantial change in the control group. For some subscales in the intervention group, there were differences present at all 3 time points, but not necessarily across time (i.e., the average score obtained at Time 2 was higher than at the other 2 times [T1 < T3 < T2]). However, for other subscales (except for working condition) there were significant differences between Time 1 and Time 2, and also between Time 1 and Time 3, but there was no difference between Time 2 and Time 3 (T1 < T2, T1 < T3). The stress recognition subscale showed the most significant difference between intervention and control groups both at 1 month (Time 2) and 3 months (Time 3) after the intervention. Subscales such as teamwork climate and safety climate showed significant results with a $p < 0.05$ at Time 2 and at Time 3, although only safety climate ($p < 0.05$) and stress recognition ($p < 0.01$) demonstrated significant group differences.

Assessment on the NOTECHS by attending surgeons is provided in Table 3. The total NOTECHS score and its 4 component scores measured at the 3 time points demonstrate significant improvements from baseline to 3 months after the intervention in the intervention group, while changes in the control group were not significant for any component. Except for the that showed significant differences between all three time points, with a higher score in Time 2 than at the 2 other times (T1 < T3 < T2); other domains indicated significant differences between Time 1 and Time 2 as well as between Time 1 and Time 3, but no significant difference between Time 2 and Time 3 (T1 < T2, T1 < T3). The leadership and management, as well as teamwork and cooperation domains indicated more significant results at Time 2 between intervention and control groups than at Time 3 ($p < 0.01$ vs $p < 0.05$); only for situation awareness were the differences significant at a $p < 0.01$

both 1 month and 3 months after the intervention (Time 2 and Time 3).

As indicated in Figure 2, rates of positive responses (slightly agree to strongly agree) in the intervention group in the areas of teamwork climate, safety climate, stress recognition, and job satisfaction all improved over time. The 2 components, teamwork climate and safety climate, demonstrated more than 60% positive responses in the intervention group. In contrast, positive responses regarding working conditions changed minimally over time. Stress recognition's positive responses in the intervention group at baseline was lower than 50% but increased significantly to more than 50% at both measurements after the intervention. Overall, the rate of positive responses at Time 3 was lower than at Time 2 for all subscales in the intervention group. However, in spite of the decrease of positive responses at Time 3, these were still considerably higher than at baseline.

DISCUSSION

The present study was conducted to determine the efficacy of a brief in-service education program for surgical residents in improving attitude toward PS as self-rated and their behavior based on performance as rated by attending surgeons. The findings demonstrate that such an educational program may be effective in improving many components of PS, changes that persist for at least 1 to 3 months following the intervention. However, some components such as working condition did not improve and there was a trend towards a decreasing effectiveness of the program in almost all components from 1 to 3 months following the intervention (indicating a decay in the benefits achieved).

In a similar study, Putnam et al. assessed the impact of an educational workshop on PS on attitudes and behavior of surgical residents in the United States. They compared the effect of the workshop when the program on PS was also presented with an online curriculum to reinforce the concepts taught. They found that the concurrent use of 2 educational programs may improve some behavioral components of PS, yet positive attitudes remained unchanged compared to a usual care control group (standard education about safety issues). In the 4-hour program they used methods such as didactics, small group sessions, and cooperative team building skills to improve effective communication, error recognition and safety practices among participants.[18] There are several differences between the present study and that study conducted in the United States. First, the US study used an established online curriculum for all surgical residents that they had to pass before working in the hospital, whereas in the present study conducted in Iran, there was no mandatory education program in this regard. Second, in the US study only 3 components of PS were examined (safety culture, teamwork, and speaking up) and these factors were assessed by a different scale. In contrast, the SAQ used in the present study examines 6 domains of PS. Third, the US study had a longer follow-up with assessment of outcomes at 6 and 12 months postintervention. The other important difference between these 2 studies was the number of participants, with 51 participants in the US study and 90 in the present study. Finally, there were differences in the duration of the programs (4 hours in theirs and 8 hours in ours), composition of the educational methods, and a different approach to data analysis.

Factors such as educational techniques and the comprehensive nature of the approach to address all major components of safety attitudes may have contributed to the different results between the 2 studies. For example, we used methods such as group discussion, brain storming, and demonstration that have been recognized as the most appropriate educational methods to bring about change in belief and attitude.[24] Also, as noted above, the duration of the present workshop (8 hours) was twice that of the previous study (4 hours). Furthermore, the follow-ups in the present study were of relatively short duration (1 and 3 months after the program), whereas the US study chose longer follow-up time (6 and 12 months), particularly since the impact of the educational program may diminish or extinguish over time. As Glanz et al. note, maintaining a positive attitude and behavioral change following the intervention may require booster sessions at different points for the learners.[25]

A second study assessed the attitudes and behaviors of medical residents after a PS educational program that involved four 2-day educational sessions for residents of different specialties at 5 Dutch hospitals. The participants were asked to develop an action plan to improve PS and 3 months later a semistructured interview was conducted to evaluate the results of their action plan. Nearly 90% of participants reported some actions and about half of residents indicated they had completed an action plan. Although many actions were implemented by residents based on their plans, there still remained a significant gap between intentions and actual behaviors. The authors concluded that supplemental education – similar to that conducted in the current study – may be necessary to fill such gaps.[26] The present study involved a brief multifaceted educational program that produced a positive shift in attitude concerning PS that also appeared to result in behavior change, at least in the short term. When we compared the results of SAQ with those based on surgery attending's ratings on the NOTECHS scale, both indicated positive results over time.

Finn et al. recently investigated supervision provided by attending physicians to improve PS in medical residents. Regular supervision by attending physicians was increased to determine the success of this intervention on quality of general medical services provided by the residents. Researchers followed participants for 9 months, finding no significant difference in terms of medical errors between residents who received the increased supervision and those who did not. Furthermore, residents in the intervention group had lower feelings of efficiency and autonomy compared to the control group.[27] Thus, this study suggested that direct supervision cannot guarantee better PS and lower medical errors in residency education programs. Rather, the use of well-designed interactive education programs directed at changing attitude and behavior may be necessary.

An interesting but not surprising finding of the present study was that all PS attitudes improved significantly after the program except working condition. This indicates that interventions such as those used in the present study may not be sufficient to produce change in residents' attitude regarding their working conditions and that other factors may be at play that were not considered. For example, the working condition domain may be affected by number of staff available to provide necessary healthcare, as well as by the type of continuing medical education provided to hospital staff, and overall education of the treatment team, along with continuous monitoring of healthcare decisions in this regard.[20] These factors may be more important in determining working conditions than providing education alone on attitudes and behavior of surgical residents regarding PS.

Stress recognition was a component that the SAQ assessed, and low baseline scores in the present study suggest need for further attention, given that many studies have reported this to be one of the most important factors affecting medical errors and PS.[28-30] This involves the excessive workload that may be placed on healthcare professionals, including surgical residents. Furthermore, there is some evidence indicating that healthcare providers lack the ability to effectively manage their stress or have limited coping skills to overcome stressful situations.[28,31] Perhaps, providing stress management workshops similar to that provided in the current study may help surgical residents use more effective coping strategies and consequently lead to reduced medical errors.

Despite changes in subscale scores on job satisfaction and perception of management in the intervention group overtime, there was no significant difference between groups after the intervention for these subscales. Our educational program addressed these dimensions. For example, we provided a lecture on job satisfaction and how to improve this component on surgical wards and also presented instructions regarding communication with administrators. Since in addition to psychological and subjective factors that may influence such variables, there are many structural and organizational factors that may be influential as well. Thus, affecting those aspects of PS may be beyond a relatively brief educational program can provide. Additional measures such as holding similar educational courses for hospital managers, along with providing job benefits for surgical residents as well as other healthcare personnel who work in surgical settings may further enhance these aspects of PS.

Several limitations in the current study should be acknowledged. First, participants volunteered to participate in the study and were not a representative sample of surgical residents in Iran. Thus, conducting this study in surgical residents at other hospitals or regions of Iran may lead to different results. Second, although using surgery attending's ratings on the NOTECHS scale may provide a more objective measure of change in resident behavior, the main outcome in studies of this type involves frequency of medical errors. However, because there is no reliable and valid measure of determining such errors in Iranian hospitals, we were unable to measure this key outcome. Third, the long-term effect of educational interventions such as the one implemented in this study is not clear, since we did not have adequate time and resources to follow participants for a longer period. Therefore, it is possible that the effects of this educational intervention may not last over time, as was suggested by a decline in the rate of improvement from the 1-month to the 3-month follow-up. Finally, there are many other factors that may affect PS in operating rooms or other surgical settings besides surgical resident attitude and behavior that require improvement to maximize this outcome. Identifying such factors and including them in educational interventions may lead to further reductions of medical errors and improvement of PS.

CONCLUSIONS

The results of this educational program that involved interactive and group-based learning methods suggest that interventions of this type may produce attitudinal and behavioral changes in the surgical residents that could improve PS in hospital settings. Since educational interventions such as the one examined here may also be effective for other healthcare personnel and for different specialties in medical settings, evaluating their efficacy in nurses, medical physicians, anesthesiologists, and emergency medicine specialists – both during and after their training – may help to reduce the high risk of

medical errors. However, the present educational program may need to be tailored to the specific healthcare professionals and their job role. Designing interventions with longer follow-up to identify the efficacy of such program over time, as well as implementing a reliable and valid measure of recording medical errors, are also recommended for future studies.

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