RESEARCH ARTICLE

Translation and Psychometric Properties of the Persian Version of Oxford Non-technical Skills 2 System: Assessment of Surgical Teams' Non-technical Skills in Orthopedic Surgery Wards

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Research performed at at two selected public hospitals of Tehran, Iran

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Abstract

Background: Non-technical skills are interpersonal and cognitive skills involved in safe performance and preventing adverse events during surgery. it is necessary to dominate the non-technical skills to ensure patient safety. This study has aimed to assess the validity and reliability of Oxford Non-technical skills 2 system (Oxford NOTECHS 2) in Iran and to evaluate surgical teams' non-technical skills in orthopedic surgery wards.

Methods: This cross-sectional study was conducted in Tehran, Iran during 2015. The level of evidence is III based on Canadian Task Force on the Periodic Health Examination. We followed the Beaton's guideline for Persian translation and cross-cultural adaptation of the checklist. In this study, 60 orthopedic surgical team members working in two selected public hospitals were selected by cluster random sampling method.Oxford NOTECHS 2 system which is consisted of four subscales including leadership and management, teamwork and collaboration, decision-making and problem-solving, and situational awareness was used to collect the data.

Results: The overall mean score of non-technical skills was 69.52±6.64. The mean score for surgery, anesthesia, and nursing sub-teams were 24.98±3.71, 21.12±4.29, and 23.42±3.60, respectively. The teams' scores in total, leadership and management, teamwork and collaboration, problem solving and decision making, and situational awareness at the standard level were 74.70%, 76.95%, 73.75%, 66.87%, and 74.70% of maximum score, respectively.

Conclusion: The validity and reliability of the Persian version of Oxford NOTECHS 2 scale in Iran was confirmed. The results of this study showed that surgical teams' non-technical skills were at a moderate level in orthopedic surgery wards. The minimum score of the surgical teams' non-technical skills belonged to anesthesia and maximum to surgery sub-team. Using the training programs and setup workshop is recommended to improve the surgical teams' non-technical skills, especially surgery-nursing sub-team.

Level of evidence: III

Keywords: Non-technical skills; Operating room, Orthopedic surgery, Oxford non-technical skills 2, Oxford NOTECHS 2, Persian version

Introduction

Non-technical skills consist of a) interpersonal skills such as communication, leadership, and teamwork; and b) cognitive skills such as decision-making, situational awareness, and mental readiness, which are complementary of technical skills (1). These skills are distinct from psychomotor and play an important role in

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safe and efficient performance in surgery (2, 3). A safe surgery depends on the abilities of surgical team members in combining the non-technical skills with technical ones (4). Empirical evidence supports the theory that although technical skills are necessary, they are not sufficient to achieve a high level of surgical performance (1). Non-technical skills including situational awareness, decision-making, problem-solving, teamwork, leadership, cooperation, management, etc., are essential for work in the operating room, causing a reduction in probable errors and preparing an appropriate response to the upcoming difficulties and problems (5). On the other hand, it seems that good non-technical skills are a part of experienced surgeon's behavior during surgery (6).

About 234 million surgeries are done worldwide every year which are very important due to their abundance, the importance of patient safety, and quality (7). More than 60% of medical unpleasant events can afflict the patient who undergoes a surgical operation (6). It was also reported that 41% of hospitals' adverse events occur in the operating rooms (the most common place in hospitals), while half of these events are preventable (8). Investigating the reasons for occurrence of the errors shows that they are due to non-technical skills rather than technical ones (9). Studying the behavior in the operating room showed that defects in non-technical skills are not rare and can lead to adverse events (6). Unfortunately, little attention has usually been paid to the behavioral components of safe medical practice (10). Operation room practitioners often complain that their colleagues don't understand their priorities or they seem to be pursuing conflict goals (11). Observing medical teams in surgery has highlighted difficulties arising from the deficiency in awareness of the situation and poor interaction of team members (12). Non-technical skills are effective for safer surgery (13) and have a protective role against human fallibility and its subsequent events (5). These skills will enhance performance and increase patients' safety (6). High levels of non-technical skills such as teamwork and communication in operation room can an increase the quality of surgery (14).

Crew Resource Management programs pave the way for creating the Oxford NOTECHS (Non-Technical Skills) in order to investigate the teams' non-technical skills (15). This aspect of study has been studied in some investigations in civil aviation linking the safety of airlines to the culture of their crew (16). Between the years of 1959 and 1989, more than 70% of commercial plane crashes occurred because of weakness in non-technical skills of flight crew members instead of purely mechanical failure (17). Recently, assessment and training of non-technical skills have been adopted in healthcare (18). Observational assessment tools have been created to evaluate the skills of the anesthetist, the surgeon, and the scrub nurse in operation room (6, 8, 19). Wauben et al. in a study about the situation of non-technical skills in surgery showed that there was a significant difference between the surgeon and other team members in many behavioral dimensions (20). Gillespie et al. in their prospective study using revised NOTECHS found an inverse relationship between miscommunication and interruptions and team's nontechnical skills (21). Robertson et al. in a study using Oxford NOTECHS II showed that there was no significant difference between the surgical team members in the mean score of non-technical skills (22).

Research on non-technical skills of surgical procedure is relatively new, but almost all studies in this field are conducted in Europe and the United States (15). To the best of our knowledge, this issue has not been previously investigated in Iran. Behavioral markers system was used to evaluate non-technical skills and the underlying behavior performance (23). These markers are non-technical and observable behaviors that affect performance in work environments (24). Regarding the importance of these skills in creating a safe surgery and patient safety, examining the skills in the operating room is essential. Furthermore, no study has been conducted in none-teaching hospitals on non-technical skills of the whole surgical team. The present study was exclusively conducted in operating rooms of orthopedic wards.

Objectives

This study has aimed to assess the validity and reliability of Oxford NOTECHS 2 system in Iran and evaluate the surgical teams' non-technical skills in orthopedic surgery wards.

Materials and Methods

Study Design and Population

This cross-sectional study was conducted on 60 orthopedic surgical team members working in two selected public hospitals in Tehran, Iran, during the year 2015.

The teams were selected based on cluster random sampling method. One ward (orthopedic ward) was randomly selected from each hospital. Next, a number of surgical operations in each hospital were selected using the probability proportional to size sampling.

Based on previous studies and sample size formula for one sample, the minimum sample size for this study was 58 teams members (25).

$$n = \frac{z_{1-\alpha/2}^2 S^2}{d^2} = \frac{1.96^2 * 0.97^2}{0.25^2} = 57.80$$

The inclusion criteria were: (a) willingness to participate in the study, (b) members of the surgical team consisting of six people, and (c) at least one member of the team being different. The entrance of unauthorized people like trainees into the operating room could deviate normal data gathering because the hospitals were not educational centers, So the surgeries in which trainees were involved, were excluded.

Data Collection Tool

Data were collected using a checklist on demographic data (gender, age, marital status, and work experience) and the Persian Oxford Non-Technical skills system 2 (NOTECHS 2).

The Oxford NOTECHS 2 checklist was used to assess the non-technical skills of the surgical team members. This

observational assessment tool evaluates four behavioral dimensions including: 1) leadership and management; 2) teamwork and collaboration; 3) problem solving and decision making; and 4) situational awareness about the following three subgroups: 1) surgery subgroup (surgeon, assistant surgeon), 2) anesthesia subgroup (anesthesiologists and anesthesia technician), and 3) nursing (scrub and circular nurses) (22). The scoring system presents exact personal information about the quality of the non-technical skills in each subgroup based on the scale of 1 to 8 for each behavioral area [Table 1] (22). The standard- based level of each behavior is the score of 6 (22). Hence, a mean score that is higher than 72 shows that the level of non-technical skills is higher than the standard-based level. The maximum scores for each team member and each behavior are 32 and 24, respectively.

Reliability and validity of NOTECHS 2

To translate Oxford NOTECHS 2 scale from English into Persian language, we used the standard forward-backward technique. In the beginning, the scale was translated into Persian independently by two bilingual experts in the field of operation room and psychology. Then, back-translation was conducted by two different independent translators and at the end the coordinator provided the Persian version of the Oxford NOTECHS 2 scale by comparing and adapting the translations.

Content validity ratio (CVR) and content validity index (CVI) were used to check the content validity. Items of scale were given to 20 experts (including 5 surgeons, 5 scrub nurses, 5 anesthesiologists and 5 anesthesia technicians) and they were asked to investigate each item based on CVR and CVI. CVR and CVI for all items were at an acceptable level (CVR>0.42 and CVI>0.79).

Constructed validity was assessed by confirmatory factor analysis. The Chi-square index was divided by the degrees of freedom (2.435), Root Mean Square Error of Approximation (0.075), Comparative Fit Index (0.932), and Tucker-Lewis Index (0.904). All goodness-of-fit indexes were in the acceptable level.

The reliability of the internal consistency of the Oxford NOTECHS 2 scale was assessed using the Cronbach's alpha. The Cronbach's alpha for total, leadership, and management, teamwork and co-operation, problem-solving and decision-making, and situation awareness subscales of Oxford NOTECHS 2 scale were 0.841, 0.834, 0.756, 0.821, and 0.734, respectively. Cronbach's alpha for all dominions were in acceptable range, i.e. >0.7.

Concurrent validity of the Oxford NOTECHS 2 scale was evaluated using the Pearson correlation coefficient and Intra-class Correlation Coefficient (ICC). ICC (3,1), based on a two way mixed model ANOVA, was used for assessing the consistency (26). ICC is a value between zero and one, where 1 shows a perfect reliability. An ICC greater than 0.4 was considered as acceptable level (26). For this purpose, two trained observers including a human factors expert and an experienced specialist in the operating room in ten operations were scored separately. The observers were trained by using training videos, surgical scenarios, advice and council of experienced practitioners of operating room and also more than two years of study about teamwork and non-technical skills in the operation room. The Pearson's correlation coefficient and ICC for scores of two observers in 10 operations were 0.913 and 0.921, respectively. Thus, concurrent validity of Oxford NOTECHS 2 scale was confirmed. In order to reduce the bias of expert rater scoring and high correlation between scores, the 2 observes rated 1 score in any behavior of sub-teams.

Ethical Considerations

The researchers entered the surgical wards after obtaining the hospitals authorities' permission and the consents from both the surgeon and patient. Also, they didn't disturb the activities of the team members in the operating room. The personal information of the surgical team members and also the patients' personal information remained confidential. Finally, the participants were assured that their information would not be used for any purpose other than this work.

Statistical Analysis

The normality condition of the quantitative variables was investigated using Shapiro-Wilks test. Normally distributed quantitative variables were demonstrated as mean ± standard deviation. One-way ANOVA was used to compare the mean scores of behaviors in subgroups. Chi-square test was used to evaluate the homogeneity of the ratio of standard to non-standard surgery operations. Pearson's correlation coefficient was employed to evaluate the relationship between subscales of Oxford NOTECHS 2. A $P<0.05$ was considered as statistically significant. Statistical analysis was conducted using SPSS version 24 and Mplus version 7.

Results

The mean age and work experience of the participants in this study were 42.81±8.57 and 10.62±6.18 years, respectively. Of the 360 participants, 224 (62.2%) were male and 316 (87.7%) were married. The sex ratio ($P=0.754$) and the proportion of married people ($P=0.823$) showed no statistically significant difference in various groups. The mean duration of the 60 operating theater was 88 min (median: 90, SD: 37, range: 30-180 min).

The overall mean score of non-technical skills computed with Oxford NOTECHS scale was 69.52±6.64 (the minimum and maximum possible score are 12 and 96 for total and 3 and 24 for each dominions). Table 2 shows detailed information about the scores of Oxford NOTECHS scale.

The scores of sub-teams in total, leadership and management, teamwork and collaboration, problem solving and decision making, and situational awareness at the standard level were 74.70%, 76.95%, 73.75%, 66.87%, and 74.70% of maximum score, respectively.

In total, the mean scores of Oxford NOTECHS 2 scale for surgery, anesthesia, and nursing sub teams were 24.98±3.71, 21.12±4.29, and 23.42±3.60, respectively. The mean of teamwork and collaboration, problem solving and decision making, and situational awareness subscale were different in subgroups (surgery-anesthesiology, surgery-nursing, and anesthesiology-nursing). Table 3

Table 1. Behavioral items of Oxford NOTECHS 2

Behavior Quality	Score	Frequency
compromises in patient safety and effective teamwork	1	Consistently
	2	Inconsistently
Could directly compromise patient safety and effective teamwork	3	Consistently
	4	Inconsistently
Maintains effective level of patient safety and teamwork	5	Consistently
	6	Inconsistently
Enhances patient safety and effective teamwork	7	Consistently
	8	Inconsistently

Table 2. Summary of quantitative results of Oxford NOTECHS scores

Subscale	Mean (SD)	Confidence Interval
leadership and management	18.47 (2.19)	(17.90 , 19.03)
teamwork and collaboration	17.07 (2.32)	(16.47 , 17.67)
problem solving and decision making	16.05 (2.12)	(15.50 , 16.60)
situational awareness	17.93 (2.38)	(17.32 , 18.55)
Total	17.93 (2.38)	(17.32 , 18.55)

Table 3. Three subgroups' mean scores in each area of non-technical skill

Subscale	Subgroup	Number	Mean (SD)	*P-value*
leadership and management	Surgery (A)	60	6.30 (1.27)	0.599
	Anesthesiology (B)	60	6.07 (1.47)	
	Nursing (C)	60	6.10 (1.07)	
	Total	180	18.47 (2.19)	
teamwork and collaboration	Surgery (A)	60	6.03 (1.13)	<0.001* A vs B < 0.001* A vs C: 0.514 B vs C < 0.001*
	Anesthesiology (B)	60	4.75 (1.31)	
	Nursing (C)	60	6.28 (1.28)	
	Total	180	17.07 (2.32)	
problem solving and decision making	Surgery (A)	60	6.20 (1.20)	<0.001* A vs B < 0.001* A vs C < 0.001* B vs C: 0.026*
	Anesthesiology (B)	60	4.65 (1.25)	
	Nursing (C)	60	5.20 (0.99)	
	Total	180	16.05 (2.12)	
situational awareness	Surgery (A)	60	6.45 (1.17)	0.002* A vs B: 0.003* A vs C: 0.027* B vs C: 0.720
	Anesthesiology (B)	60	5.65 (1.33)	
	Nursing (C)	60	5.83 (1.39)	
	Total	180	17.93 (2.38)	
Total	Surgery (A)	60	24.98 (3.71)	<0.001* A vs B: 0.072 A vs C < 0.001* B vs C: 0.004*
	Anesthesiology (B)	60	21.12 (4.29)	
	Nursing (C)	60	23.42 (3.60)	
	Total	180	69.52 (6.64)	

*significant at 5%

Table 4. The prevalence of standard score in each dimension of non-technical skill

Subscale	Subgroup	Nonstandard	Standard		*P-value*
leadership and management	Surgery (A)	6 (10%)	54 (90.0%)	60	0.145
	Anesthesiology (B)	13 (21.7%)	47 (78.3%)	60	
	Nursing (C)	7 (11.7%)	53 (88.3%)	60	
	Total	26 (14.4%)	154 (85.6%)	180	
teamwork and collaboration	Surgery (A)	7 (11.7%)	53 (88.3%)	60	<0.001
	Anesthesiology (B)	39 (65.0%)	21 (35.0%)	60	
	Nursing (C)	9 (15.0%)	51 (85.0%)	60	
	Total	55 (30.6%)	125 (69.4%)	180	
problem solving and decision making	Surgery (A)	8 (13.3%)	52 (86.7%)	60	<0.001
	Anesthesiology (B)	40 (66.7%)	20 (33.3%)	60	
	Nursing (C)	24 (40.0%)	36 (60.0%)	60	
	Total	72 (40.0%)	108 (60.0%)	180	
situational awareness	Surgery (A)	5 (8.3%)	55 (91.7%)	60	0.004
	Anesthesiology (B)	19 (31.7%)	41 (68.3%)	60	
	Nursing (C)	17 (28.3%)	43 (71.7%)	60	
	Total	41 (22.8%)	139 (77.2%)	180	
Total	Surgery (A)	13 (21.7%)	47 (78.3%)	60	<0.001
	Anesthesiology (B)	43 (71.7%)	17 (28.3%)	60	
	Nursing (C)	24 (40.0%)	36 (60.0%)	60	
	Total	80 (44.4%)	100 (55.6%)	180	

*significant at 5%

Table 5. The Pearson's correlation coefficient between subscales

Subscale	1	2	3	4
leadership and management (1)	1			
teamwork and collaboration (2)	0.381 (0.003*)	1		
problem solving and decision making (3)	0.287 (0.026*)	0.375 (0.003*)	1	
situational awareness (4)	0.410 (0.001*)	0.483 (<0.001*)	0.384 (0.002*)	1
Total (5)	0.702 (<0.001*)	0.768 (<0.001*)	0.683 (<0.001*)	0.785 (<0.001*)

*significant at 5%

displays more information on this case.

The ratios of standard to sub-standard operations were different in total, teamwork and collaboration, problem solving and decision making, and situational awareness. Table 4 provides information on the field.

The results of this study showed that there was a significant positive correlation between the dimensions of the Oxford NOTECHS 2 scale [Table 5].

Discussion

This study was aimed to investigate the surgical teams' non-technical skills in two hospitals in Tehran city, Iran. The validity and reliability of Persian version of Oxford NOTECHS 2 was confirmed. Results showed

that the surgical teams' non-technical skills were lower than the standard level (score of 72). Leadership and management achieved the highest score among 4 dominions of non-technical skills. Surgery subgroup (including the surgeon and assistant) achieved the highest score among the three subgroups.

Comparison of the total score of non-technical skills in this study with the other similar studies showed that it was lower than the previous ones. Robertson et al. reported an average score of 73.29 for non-technical skills and also Morgan et al. in their study reported a higher mean score (71.62 before the intervention and 75.44 after the intervention) (16, 22). Lack of exact planning and proper timing of operation in the hospitals could be the reasons of lower score in this study. Different results could be due to differentiation of the studied wards and teaching versus non-teaching type of hospitals. In the teaching hospitals, the assistant surgeon is usually a resident of surgery, but in non-teaching hospitals the assistant surgeon is an experienced specialist of operating room. Also, the other factor which could be a reason of these different scores is electiveness of some surgeries which were examined in the previous study (22).

Comparison of the subgroups of surgery teams revealed that the highest score among the subgroups was achieved by surgery subgroup. This result is consistent with that of previous studies via Oxford NOTECHS (22, 27). As the surgeon has more authority than the other team members, skills like leadership & management and problem solving & decision-making are more visible in surgical subgroups. The surgeon, as the team leader, determines the track, and regarding the current situation gives necessary orders to the members.

The score of non-technical skills among nursing subgroup was higher than that of the anesthesiology subgroup, as well as other similar studies (22, 27). The low scores of anesthesiology subgroups could be due to lack of anesthesiologist's enough presence in operation room and sometimes neglecting of anesthesia technician about ongoing process in comparison to the nursing subgroups which are present in operation room until the end of operation. In our observations, nursing sub-teams were more active than anesthesia ones who sometimes did not attend the surgery process and patient sufficiently.

In investigating the dimensions of leadership and management, it was found that all three subgroups achieved scores higher than the standard base, and the surgical subgroup had the highest average (6.30 of 8). It was consistent with the study of Mishra et al. (27) which investigated the non-technical skills by using Oxford NOTECHS. The nursing and anesthesiology subgroups were in the second and third place in both studies. Also, in studies done using observational teamwork assessment for surgery (OTAS), leadership dimension in the surgery subgroup achieved the highest score in pre- and post-operative phases of surgery, respectively (28, 29). In all surgeries, the surgeon does the duties as the team leader and manages all affairs performed in the operating room; this is the reason why the management and leadership scores of the surgery subgroup are the highest in different studies. In fact, the surgeon has the main authority for the operation and leadership is an essential skill for surgeons.

In teamwork and cooperation dimension, the scores of nursing subgroup were higher than other two groups. This result is consistent with those of previous studies of Kalantari et al. by OTAS tool and Makary et al. using Safety Attitudes Questionnaire (29, 30). According the observations, the nursing subgroup was the only one who remained at operation room from beginning to the end of the operation and observed other members' need continuously. The presence of 2 members of nursing subgroup in operation room during the operation can be the reason of their higher score. According to the existing hierarchy, nurses usually do their duties based on the principles and the rules, whereas the surgeons have greater authority and more freedom to work. Some studies, however, are in contrast with this study. Hull et al. in their study by OTAS reported a higher score in the anesthesiology subgroup (25). Also, Wauben et al., Mishra et al. and Sexton et al. reported higher scores in the surgery subgroup (20, 27, 31). These differences can be related to the difference in operational wards which were studied and different levels of non-technical skills training. Regarding this inconsistency, it can be said that non-technical skills such as teamwork, depend on personal and organizational factors, as well.

In the situation awareness dimension, the scores of surgery subgroup were higher than other subgroups. This result is consistent with those of previous studies (20, 27). Also, Undre et al. using the OTAS tool found that the surgery subgroup's scores were high before and during the operation and anesthesiology subgroup scores were high in the post-operation phase (28). Situational awareness is an important factor in the quality of surgery which consists of three factors: 1) understanding the environment, 2) perceiving features of the elements, and 3) predicting the near future. All team members must attend the operation process completely and have the ability to predict the oncoming situation. The higher score of the surgery subgroup was predictable due to the higher responsibility of the surgeon. Hull et al., however, showed that the anesthesiology subgroup was better than the others (25). This result can be due to continuous attention of anesthesia sub-team to the patient and procedure; however, in our study it was not observed adequately.

The surgery subgroup's scores were higher than those of the other two groups in problem solving and decision making which are consistent with a similar previous study (27). Also, there was a significant difference between the surgery team's scores and other subgroups ($P<0.001$). According to the surgeon's higher responsibility in directing the team and giving orders about the progress of the surgery procedure, the result is predictable, but this high difference between the surgery subgroup and the other two subgroups is worrying and can have a negative impact on the patient safety.

Regarding the results, there were domains whose score was lower than the standard level. Furthermore, discrepancies in the scores of triple sub-teams are worrying. It seems that using the training programs can be useful in order to improve the non-technical skills in operation room practitioners. Training programs in non-technical skills have resulted in improvements in attitudes to theatre safety, team non-technical performance, and also reduction in technical error rates (32). The importance of educational interventions is obvious in the study of Morgan et al. (16). In the mentioned study, the total score of non-technical skills' using Oxford NOTECHS 2 system was 71.62. After intervention and necessary training for the operation room personnel, it increased to 75.44, while the control group which was not taught had a decrease in scores from 72.09 to 70.09. Including at least one course as non-technical skills for surgery in college curriculum for students who will be employed in operation rooms is necessary according to available evidence. Unfortunately, there is no specific and systematic teaching course on non-technical skills for learners who are employed in operating room.

In addition, strategies such as using teams with fixed schedule may be effective in improving conditions because members are more familiar with each other's characteristic and non-technical skills features and can coordinate better in the form of a fixed team. Moreover, exact scheduling and timing in arranging the operations and also applying the policy in order to keep all the team in the operating room until the end of operations are strategies which can increase non-technical skills' scores and lead to increase in the patient safety and better outcomes.

Doing the study exclusively in the orthopedic parts is one of the advantages of the research which make the results of all surgeries more comparable with each other. In previous studies, the surgeries were selected from different parts; therefore, the results were inevitably different, making their comparison difficult. Also, all the surgical teams had different arrangements. There are no two identical teams. Using two observers for determining the scores reduced the observer bias. It was the first study about various non-technical skills of surgical teams in Iran and its results are especially extensible to operation rooms of non-teaching hospitals.

This study had several limitations. One limitation was that despite the approval by the hospital administrators, surgeons sometimes didn't allow the researchers to attend the operating room. The presence of trainees at the hospital prevented the collection of data on many surgeries due to the increased number of participants of the team. Another limitation of the study was the impossibility of the intervention.

It is recommended that future research should be done using educational and policy interventions. Also, non-technical skills in various hospital surgery wards are recommended to be investigated.

The Oxford NOTECHS 2 is an exact, suitable and reliable tool for evaluation of the surgical team's non-technical skills in Iran. The results of this study showed that the behaviors of surgery subgroup's in all dimensions were higher than the base standard, while nursing subgroups' behavior scores were higher than the standard only in the dimensions of leadership and management as well as cooperation and teamwork. The mean score was lower than the standard base and significant difference of the scores between the subgroups of three surgical sub teams is the cause of concern; therefore, using interventions such as training of non-technical skills, creating and enforcing policies for the full presence of members of the surgical team in the operating room, and using a fixed schedule for the teams can be effective in improving the conditions.

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References

1. Hull L, Arora S, Kassab E, Kneebone R, Sevdalis N. Observational teamwork assessment for surgery: content validation and tool refinement. J Am Coll Surg. 2011; 212(2):234-43.e1-5.
2. Mitchell L, Flin R. Non-technical skills of the operating theatre scrub nurse: literature review. J Adv Nurs. 2008; 63(1):15-24.
3. Mitchell L, Flin R, Yule S, Mitchell J, Coutts K, Youngson G. Thinking ahead of the surgeon. An interview study to identify scrub nurses' non-technical skills. Int J Nurs Stud. 2011; 48(7):818-28.
4. Greenberg CC, Regenbogen SE, Studdert DM, Lipsitz SR, Rogers SO, Zinner MJ, et al. Patterns of communication breakdowns resulting in injury to surgical patients. J Am Coll Surg. 2007; 204(4):533-40.
5. Flin R. Non-technical skills for anaesthetists, surgeons and scrub practitioners (ANTS, NOTSS and SPLINTS). London: The Health Foundation; 2013.
6. Yule S, Flin R, Maran N, Rowley D, Youngson G, Paterson-Brown S. Surgeons' non-technical skills in the operating room: reliability testing of the NOTSS behavior rating system. World J Surg. 2008; 32(4):548-56.
7. Haugen AS, Softeland E, Eide GE, Sevdalis N, Vincent CA, Nortvedt MW, et al. Impact of the World Health Organization's Surgical Safety Checklist on safety culture in the operating theatre: a controlled intervention study. Br J Anaesth. 2013; 110(5):807-15.
8. Mitchell L, Flin R, Yule S, Mitchell J, Coutts K, Youngson G. Evaluation of the scrub practitioners' list of intraoperative non-technical skills system. Int J Nurs Stud. 2012; 49(2):201-11.
9. Yule S, Flin R, Paterson-Brown S, Maran N. Non-technical skills for surgeons in the operating room: a review of the literature. Surgery. 2006; 139(2):140-9.
10. Flin R, Patey R, Glavin R, Maran N. Anaesthetists' non-technical skills. Br J Anaesth. 2010; 105(1):38-44.
11. Undre S, Sevdalis N, Healey AN, Darzi S, Vincent CA. Teamwork in the operating theatre: cohesion or confusion? J Eval Clin Pract. 2006; 12(2):182-9.
12. Flin R, Glavin R, Maran N, Patey R. Framework for Observing and rating anaesthetists' non-technical skills; anaesthetists' non-technical skills (ANTS) system handbook v1. 0. 2012. Aberdeen, Scotland: University of Aberdeen; 2014.
13. Passauer-Baierl S, Hull L, Miskovic D, Russ S, Sevdalis N, Weigl M. Re-validating the Observational Teamwork Assessment for Surgery tool (OTAS-D): cultural adaptation, refinement, and psychometric evaluation. World J Surg. 2014; 38(2):305-13.
14. Seelandt JC, Tschan F, Keller S, Beldi G, Jenni N, Kurmann A, et al. Assessing distractors and teamwork during surgery: developing an event-based method for direct observation. BMJ Qual Saf. 2014; 23(11):918-29.
15. Sevdalis N, Davis R, Koutantji M, Undre S, Darzi A, Vincent CA. Reliability of a revised NOTECHS scale for use in surgical teams. Am J Surg. 2008; 196(2):184-90.
16. Morgan L, Hadi M, Pickering S, Robertson E, Griffin D, Collins G, et al. The effect of teamwork training on team performance and clinical outcome in elective orthopaedic surgery: a controlled interrupted time series study. BMJ Open. 2015; 5(4):e006216.
17. Rutherford JS, Flin R, Mitchell L. Non-technical skills of anaesthetic assistants in the perioperative period: a literature review. Br J Anaesth. 2012; 109(1):27-31.
18. Flin R, Patey R. Non-technical skills for anaesthetists: developing and applying ANTS. Best Pract Res Clin Anaesthesiol. 2011; 25(2):215-27.
19. Fletcher G, Flin R, McGeorge P, Glavin R, Maran N, Patey R. Anaesthetists' Non-Technical Skills (ANTS): evaluation of a behavioural marker system. Br J Anaesth. 2003; 90(5):580-8.
20. Wauben LS, Dekker-van Doorn CM, van Wijngaarden JD, Goossens RH, Huijsman R, Klein J, et al. Discrepant perceptions of communication, teamwork and situation awareness among surgical team members. Int J Qual Health Care. 2011; 23(2):159-66.
21. Gillespie BM, Harbeck E, Kang E, Steel C, Fairweather N, Chaboyer W. Correlates of non-technical skills in surgery: a prospective study. BMJ Open. 2017; 7(1):e014480.
22. Robertson ER, Hadi M, Morgan LJ, Pickering SP, Collins G, New S, et al. Oxford NOTECHS II: a modified theatre team non-technical skills scoring system. PLoS One. 2014; 9(3):e90320.
23. Sharma B, Mishra A, Aggarwal R, Grantcharov TP. Non-technical skills assessment in surgery. Surg Oncol. 2011; 20(3):169-77.
24. Graham J, Hocking G, Giles E. Anaesthesia non-technical skills: can anaesthetists be trained to reliably use this behavioural marker system in 1 day? Br J Anaesth. 2010; 104(4):440-5.
25. Hull L, Arora S, Kassab E, Kneebone R, Sevdalis N. Assessment of stress and teamwork in the operating room: an exploratory study. Am J Surg. 2011; 201(1):24-30.
26. Vosoughi AR, Roustaei N, Mahdaviazad H. American orthopaedic foot and ankle society ankle–hindfoot scale: a cross-cultural adaptation and validation study from Iran. Foot Ankle Surg. 2018; 24(3):219-23.
27. Mishra A, Catchpole K, McCulloch P. The Oxford NOTECHS System: reliability and validity of a tool for measuring teamwork behaviour in the operating theatre. Qual Saf Health Care. 2009; 18(2):104-8.
28. Undre S, Sevdalis N, Healey AN, Darzi A, Vincent CA. Observational teamwork assessment for surgery (OTAS): refinement and application in urological surgery. World J Surg. 2007; 31(7):1373-81.
29. Kalantari R, Zakerian SA, Mahmodi Majdabadi M, Zanjirani Farahani A, Meshkati M, Garosi E. Assessing the teamwork among surgical teams of hospitals affiliated to social security organizations in Tehran

city. J Hospital. 2016; 15(3):21-9.
30. Makary MA, Sexton JB, Freischlag JA, Holzmueller CG, Millman EA, Rowen L, et al. Operating room teamwork among physicians and nurses: teamwork in the eye of the beholder. J Am Coll Surg. 2006; 202(5):746-52.
31. Sexton JB, Makary MA, Tersigni AR, Pryor D, Hendrich A, Thomas EJ, et al. Teamwork in the operating room: frontline perspectives among hospitals and operating room personnel. Anesthesiology. 2006; 105(5):877-84.
32. Morgan L, Pickering SP, Hadi M, Robertson E, New S, Griffin D, et al. A combined teamwork training and work standardisation intervention in operating theatres: controlled interrupted time series study. BMJ Qual Saf. 2015; 24(2):111-9.