Redesigning cardiovascular healthcare: patient and professional perspectives on value

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CHAPTER V

TEAMWORK AND SAFETY ATTITUDES IN COMPLEX AORTIC SURGERY AT A DUTCH HOSPITAL: CROSS-SECTIONAL SURVEY STUDY

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Abstract

Background

Improving teamwork in surgery is a complex goal and difficult to achieve. Human factors questionnaires such as the Safety Attitudes Questionnaire(SAQ) can help understand medical teamwork and may aid in this task.

Objective

To assess local team- and safety culture in a cardiovascular surgery setting to understand how purposeful teamwork improvements can be reached.

Methods

Two cardiovascular surgical teams performing complex aortic treatments were assessed; a endovascular treatment team (ETT) and an open treatment team (OTT). Both teams answered an online version of the SAQ-NL consisting of 30 questions related to 6 different domains of safety (teamwork climate, safety climate, job satisfaction, stress recognition, perceptions of management, and working conditions). In addition, one open question was posed to gain more insight into the completed questionnaires.

Results

The SAQ-NL was completed by 23 (100%) ETT members and 13 (100%) OTT members. Team buildup was comparable for both teams (60% males and 50% physicians). All participants worked ≥10 years in healthcare. SAQ-NL mean scores were comparable between both teams, important differences were found between the physicians and non-physicians of the ETT. Non-physicians were less positive about the safety climate, job satisfaction and working climate domains than physicians ($p<.05$).

Additional education on performed procedures, more conjoined team training as well as a hybrid OR were suggested by participants as important areas of improvement.

Conclusion

Non-physicians of a local team performing complex endovascular aortic aneurysm surgery perceive safety climate, job satisfaction and working conditions less positive than physicians of the same team. Open questions suggested this is related to lack of adequate conjoined training, education, and an adequate operating room. With added open questions, the SAQ-NL appears to be an assessment tool which allows developing strategies that are instrumental in improving quality of care.

Abbreviations

CMAQ	Cockpit Management Attitudes Questionnaire
CRM	Crew Resource Management
ET(T)	Endovascular Treatment (Team)
FMAQ	Flight Management Attitudes Questionnaire
HF	Human Factors
ICU	Intensive Care Unit
ICUMAQ	Intensive Care Unit Management Attitudes Questionnaire
JS	Job Satisfaction
LUMC	Leiden University Medical Centre
OT(T)	Open Treatment (Team)
OR	Operating Room
PoM	Perceptions of Management
SAQ	Safety Attitudes Questionnaire
SAQ-NL	Safety Attitudes Questionnaire Dutch Edition
SC	Safety Climate
SR	Stress Recognition
TC	Teamwork Climate
tSTEPPS	Team Strategies and Tools to Enhance Performance and Patient Safety
WC	Working Conditions
WHO	World Health Organization

Introduction

The World Health Organization (WHO) states that knowledge on human factors and especially non technical skills, are crucial in developing safe environments for patients(1). A 2017 analysis of the Dutch healthcare system shows that non-technical aspects of work are understudied in professional training(2, 3). Non-technical dimensions of teamwork such as communication, stress-awareness, and shared decision making, all contribute to the effectiveness of teamwork. Importantly, failing to invest in these issues may have negative effects on patient safety and clinical outcome (4-6). The challenge lies in how to identify, analyse and improve these non-technical skills.

In aviation and offshore industries for example, awareness of non-technical skills is crucial in daily work. Training and improving non-technical skills are often part of corporate policies, with proven effects on safety (7, 8). Similarly, positive results are observed in healthcare, although the number of studies is scarce (9, 10). Core to improving non-technical skills is understanding the safety culture and climate within a team. This can be assessed through questionnaires, such as the Safety Attitudes Questionnaire (SAQ)- a medical human factors (HF) questionnaire that has been validated in different medical domains. In 2016 the SAQ was validated in the Dutch language (SAQ-NL)(11, 12).

Although often used to assess an *ex ante* baseline and the *ex post* effect of team trainings, the use of the SAQ-NL as a diagnostic tool to identify what exactly needs changing within a team, and adjust subsequent training accordingly, is not common.

The outcome of complex aortic aneurysm surgery is highly dependent on team dynamics. Aortic aneurysms are defined as 'complex' when important side branches are included in the aneurysm. This necessitates inclusion of these side branches in the vascular reconstruction, making the procedure high-risk. Open, as well as endovascular complex aortic reconstructions are associated with high mortality and morbidity rates. Both treatments are conducted by multidisciplinary teams. In the current study, the SAQ-NL was used as a diagnostic tool to examine teamwork and safety climate in two types of teams; an open treatment team and an endovascular treatment team. The aim of this study was to understand, and to ultimately help improve, teamwork conditions and safety climate in this high-risk setting. Primarily it was hypothesized that (1) the SAQ-NL provides insight into how teamwork and safety is perceived by different team members, and (2) that this knowledge may help guide future teamwork improvement strategies.

Methods

Terminology

Pinpointing safety culture and safety climate within a medical department is difficult, especially because they are not mutually exclusive. The *safety culture* of an organisation is the product of individual and group values, traditions, perceptions and competences that determine the commitment to, and the style and proficiency of, an organization's health and safety management(13). An organisation's safety culture is the context in which personal safety attitudes develop, persist, and are promoted(8). It's like a 'script' that is taught to every employee, and continuously formed and (re)shaped not only by themselves, but also by their fellow 'actors' in the work setting. This concept has been used widely since the 1980s in aviation, as well as industrial settings such as power plants and offshore environments.

The *safety climate* is the manifestation of that safety culture in the behaviour and attitudes of professionals, for instance during surgical procedures. When one would make a 'snap-shot' of such environment, certain behavioural cues would be seen. For example, a surgeon being focussed on the patient and on his or her tools, the scrub-nurse seeing a drop in blood pressure and the anaesthetist reacting accordingly. This 'snap-shot' with all the interactions between professionals can be seen as the *climate* people are working in.

This *climate* (the play or the day-to-day atmosphere when working) is directly influenced by the departments *culture* (the script which consists of perceptions, beliefs, traditions). For example, when convention holds that nurses do not speak up when things go wrong, this negatively impacts safety climate, and often leads to errors and eventually diminished patient safety(14). Measuring perceptions of safety and teamwork in a specific setting at a certain point in time (i.e.; during a surgical procedure), provides insight into the *safety climate* as well as the *safety culture*.

Put differently; it allows for the assessment of how every actor plays their role and while doing so, to what extent they are influenced by others and the script used. Figure 1 gives an overview of the used terminology.

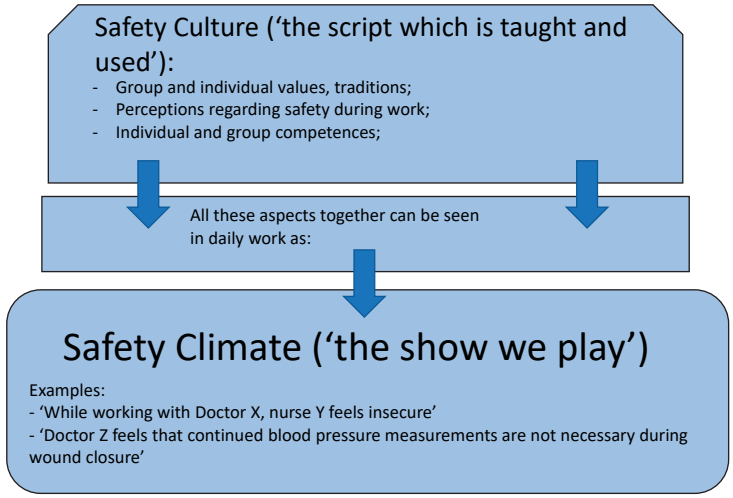

Figure 1. Safety culture and safety climate.
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Design

The current study followed a cross-sectional survey design.

Study setting

The Leiden University Medical Centre (LUMC) is one of eight university hospitals in the Netherlands. For this study, two complex aortic aneurysm treatment teams were evaluated; one conducting the endovascular treatment (ET), and the other conducting the standard open treatment (OT). Assessment of the two teams has two reasons. Firstly, the endovascular treatment is relatively new to this hospital (since 2013).Refinement of non-technical skills is of great interest in this setting, since it has been shown that this improves patient safety and outcome(10, 15). Secondly, the introduction of the endovascular treatment demanded a shift in work environment for part of the team.

The OT-team (OTT) continues to work in the familiar environment of their operating theatre, whereas the ET-team (ETT) has to perform their procedures in an angiography suite - an environment where many team members are not used to working. For daily workflow of the ETT, it is important to understand how this shift in environment influences this. An outline of a routine ETT and OTT procedure is shown in multimedia appendix 1.

Study population

The ETT consists of 23 team members and has a larger diversity of radiology personnel, surgical staff and a supplier specialist. The OTT consists of 13 team members with predominantly surgical staff and perfusionists, the latter being not included in the ETT. Noticeably, a supplier specialist is present in the ETT, but not the OTT. The specific role of the supplier specialist lies in participating in the discussion of stent-type, and design, as well as on site product advice during the procedure. The supplier specialist is a standard, crucial, team member of the ETT.

Additionally, it should be noted that 2 vascular surgeons, 1 neurologist, and 1 clinical neurophysiology technician are part of both teams. The partial overlap of members of different teams is common in medical settings. All 4 interviewees with dual team membership were able to clearly distinguish between the two teams in answering our questions. In all further analyses, vascular surgeons, thoracic surgeons, radiologists, anaesthetists and neurologists are referred to as 'physicians', whereas scrub nurses, anaesthetic nurses, clinical neurophysiology technicians, radiology technicians, specialist suppliers and perfusionists are referred to as 'non-physicians. Table 1 summarizes the physician and non-physicians composition of both teams, as well as healthcare-tenure and team-tenure.

Human Factors and the Safety Attitudes Questionnaire (SAQ)

Research into Human Factors (HF) aims to understand how humans function in different environments, in order to improve human performance and safety within these environments (16). Human Factors research has become a core part of major industries such as aviation and the offshore industry, mainly because of the high dependence on human performance and its effect on safety. Teamwork safety has been extensively evaluated in aviation through HF-questionnaires, originally through the cockpit management attitudes questionnaire (CMAQ)(7, 17).

This questionnaire assessed the perceptions concerning safety climate and teamwork among personnel working on an aircraft. This was later refined into the Flight Management Attitudes Questionnaire (FMAQ) (7).

In the medical domain, ICUs were the first to adopt a medical version of the FMAQ; the ICUMAQ(17). Developed by Sexton et al., the SAQ is a refinement of the ICUMAQ for a healthcare setting. It has proven its psychometric and clinical quality in different clinical settings, as well in Dutch (SAQ-NL)(11, 17, 18). The SAQ assesses 30 items in six domains: safety climate (SC), teamwork climate (TC), job satisfaction (JS), stress recognition (SR), perceptions of management (PoM), and working conditions (WC). The 30 items are each assessed on a 5-point Likert scale: disagree strongly, disagree slightly, neutral, agree slightly, agree strongly.

The WHO indicates that the SAQ is a valuable human factors instrument to asses medical teamwork dynamics in a standardized fashion(1). For the current study, the strong methodological foundation of the SAQ and its usability in the field were the main reasons to use it. Additionally, to gain insight into teamwork, safety attitudes and the meaning of the SAQ-NL outcomes, respondents were asked to answer the following open question: "What are your top three recommendations for improving patient safety in this clinical area"? A web based survey of the SAQ-NL (Google Forms™, Google) was sent to all ETT and OTT members (multimedia appendix 2).

Statistics

Frequency tables for gender, professional positions, team tenure and general healthcare tenure are generated to give an overview of both teams. Response patterns are shown in percentages. For normally distributed categorical data a *chi square*-test was used to calculate statistical differences. For each SAQ dimension, mean scores and standard deviations were calculated per team (ETT and OTT); per professional group (physicians and non-physicians); and per department. An unpaired *t* test was used to calculate differences between SAQ-NL mean scores for ETT and OTT teams.

A univariate ANOVA test was performed to evaluate whether there was a significant difference between average SAQ-NL scores among professional groups; the ETT and OTT ; as well as the departments. Data of the open ended questions were displayed in a descriptive manner, content analysis was used to analyse these. Two authors (ADH and JvS) labelled responses according to major that emerged from the data. Cronbach's alpha (α) was calculated for all SAQ-dimensions of our sample. For analysis, SPSS Statistics version 23 (IBM Corp., Armonk, NY, USA) was used. A *P*-value <.05 was considered significant.

Biases

Teamwork and safety are delicate subjects, leading to a risk of response bias. Examples of response bias are question order bias or social desirability bias. The use of a self-administered questionnaire via an online survey is known to minimize the latter effect(19). All questionnaire data was available only to the main researcher (ADH), who has no professional position in the ETT or OTT.

Ethical considerations

Dutch law, no ethical approval was needed to conduct this study. All participants gave consent for participating in the study and the use of their pseudo-anonymized data.

Results

Demographics

The ETT consists of 23 members of which 13(59%) are male with a total of 11(50%) physicians. The OTT consists of 13 members of which 8(61%) are male with a total of 7(53%) physicians, but not significantly different (p=.6 and p=.5, table 2). Team tenure ≥5 years was more prevalent in the ETT (55% of team members) than in the OTT (23% of team members), but not statistically different (*P*=.16, table 2). Both teams have a large proportion of members working ≥10 years in healthcare (ETT vs OTT; 86% vs 92%, *P*=.3). Long (≥50 hours) working weeks are more prevalent in the OTT than in the ETT, this difference however, was not significant (50% vs 23%, *P*=.5).

Table 1. Overview of team composition; ETT vs OTT

Teams			
ETT(N=23)	**N**	**HT**	**TT**
Radiologist	2	≥10 years	≥5 years
Thoracic surgeon	1	≥10 years	4 years
Anesthesist	3	≥10 years	≥5 years
Vascular surgeon	4	≥10 years	4 years
Neurologist	1	≥10 years	3 years
Radiology technician	5	≥10 years	≥5 years
Scrub nurse	3	8 years	≥5 years
Nurse anesthesist	1	≥10 years	≥5 years
Clinical neurophysiology technician	2	≥10 years	4 years
Supplier specialist	1	8 years	≥5 years
OTT(N=13)	**N**	**HT**	**TT**
Thoracic surgeon	1	≥10 years	3 years
Anesthesist	2	≥10 years	1 year
Vascular surgeon	3	≥10 years	≥5 years
Neurologist	1	≥10 years	4 years
Scrub nurse	2	9 years	4 years
Nurse anesthesist	1	≥10 years	4 years
Clinical neurophysiology technician	1	≥10 years	4 years
Perfusionist	2	≥10 years	≥5 years

ETT = Endovascular Treatment Team; HT = average healthcare tenure in years; N/A = not applicable;
OTT = Open Treatment Team; TT = average team tenure in years

Table 2. Demographics

	ETT	OTT	P-value
Total (N)	23	13	N/A
Male, (N,%)	13(60%)	8(61%)	P=.6
Physician (N,%)	11(48%)	7(53%)	P=.5
≥5 years team tenure (N, %)	12(55%)	3(23%)	P=.16
≥10 years healthcare tenure (N, %)	19(86%)	12(92%)	P=.3
≥50 Weekly workhours (N,%)	5(23%)	6(50%)	P=.5
Response (N, %)	23(100%)	13(100%)	N/A

ETT = endovascular treatment team

OTT = open treatment team

Mean Safety Attitudes Questionnaire-NL scores: ETT vs OTT teams

An overview of mean SAQ-NL mean scores with standard deviations (SD) per domain is shown in table 3 and figure 2. Higher means were observed for the OTT, however an independent samples *t* test showed that for all SAQ-NL domains, no statistically significant differences existed between the ETT and OTT.

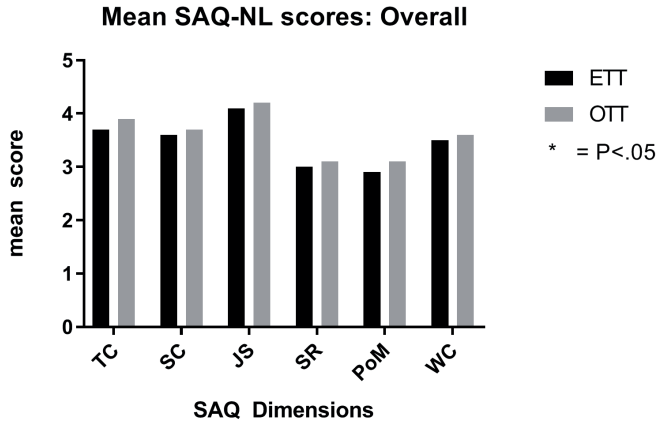
Mean scores on the SAQ-dimensions for respectively ETT and OTT were; 3.7±0.37 vs 3.9± 0.31(*P*=.40) for Teamwork Climate(TC), 3.6±0.43 vs 3.7±0.31(*P*=.65) for Safety climate (SC), 4.1±0.5 vs 4.2± 0.46(*P*=.39) for Job satisfaction (JS), 3.0±0.73 vs 3.1±0.92(*P*=.84) for Stress recognition (SR), 2.9±0.66 vs 3.1±0.51(*P*=.44) for Perceptions of Management (PoM), and 3.5±0.64 vs 3.6±0.70(*P*=.69) for Working conditions (WC). For our sample, all SAQ-domains had a reliability of $\alpha \geq .70$ (acceptable) with the exception of the TC domain (α=.58, poor).

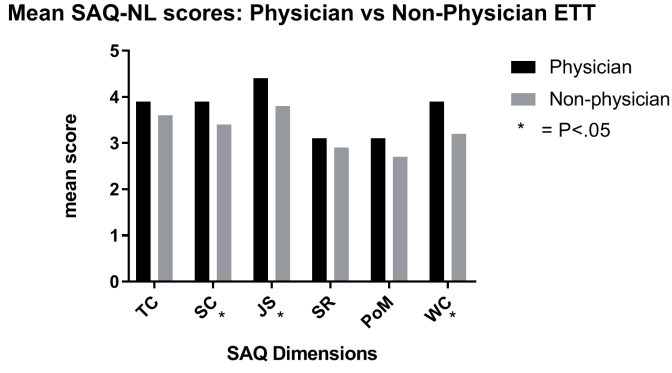
Table 3. SAQ Means scores and Standard Deviations (SD).

	TC	SC	JS	SR	PoM	WC
Team						
ETT (N=23)	3.7(0.37)	3.6(0.43)	4.1(0.50)	3.0(0.73)	2.9(0.66)	3.5(0.64)
OTT(N=13)	3.9(0.31)	3.7(0.31)	4.2(0.46)	3.1(0.92)	3.1(0.51)	3.6(0.70)
Position						
Non-physician ETT	3.6(0.43)	3.4(0.35)	3.8(0.41)	2.9(0.61)	2.7(0.67)	3.2(0.68)
Physician ETT	3.9(0.31)	3.9(0.34)	4.4(0.33)	3.1(0.86)	3.1(0.64)	3.9(0.37)
Non-physician OTT	3.8(0.40)	3.7(0.33)	4.0(0.47)	3.0(0.93)	2.9(0.43)	3.5(0.54)
Physician OTT	3.9(0.23)	3.7(0.33)	4.4(0.39)	3.1(0.98)	3.2(0.52)	3.7(0.83)
Department						
Surgery ETT	3.8(0.35)	3.7(0.39)	4.0(0.56)	3.1(0.62)	2.9(0.86)	3.3(0.56)
Anesthesiology ETT	3.9(0.26)	4.0(0.32)	4.4(0.51)	2.6(1.12)	3.0(0.00)	4.1(0.17)
Radiology ETT	3.7(0.45)	3.4(0.41)	4.1(0.46)	3.2(0.49)	2.5(0.39)	3.2(0.79)
Neurology ETT	3.4(0.2)	3.5(0.59)	4.0(0.40)	3.4(0.76)	3.6(0.53)	4.0(0.33)
Industry ETT	4.4(0.00)	4.1(0.00)	4.2(0.00)	2.0(0.00)	3.6(0.00)	4.0(0.00)
Surgery OTT	3.9(0.30)	3.7(0.38)	4.3(0.46)	3.0(1.01)	3.0(0.51)	3.5(0.39)
Anesthesiology OTT	3.6(0.34)	3.7(0.1)	4.3(0.61)	2.8(0.90)	2.8(0.00)	3.4(0.96)
Radiology OTT	n/a	n/a	n/a	n/a	n/a	n/a
Neurology OTT	4.0(0.00)	3.7(0.40)	4.1(0.42)	3.8(0.35)	3.7(0.42)	4.7(0.47)
Industry OTT	n/a	n/a	n/a	n/a	n/a	n/a
Overlapping members (N=4)						
Vascular surgeon W (ETT)	4.2(n/a)	4.2(n/a)	4.6(n/a)	2.3(n/a)	2.4(n/a)	3.7(n/a)
Vascular surgeon W (OTT)	4.2(n/a)	4.2(n/a)	5.0(n/a)	1.8(n/a)	3.4(n/a)	4.0(n/a)
Vascular surgeon X (ETT)	3.4(n/a)	3.5(n/a)	4,2(n/a)	3.8(n/a)	2.4(n/a)	3.4(n/a)
Vascular surgeon X (OTT)	4.2(n/a)	3.2(n/a)	4.4(n/a)	3.7(n/a)	2.6(n/a)	3.3(n/a)
Neurologist Y (ETT)	3.6(n/a)	4.1(n/a)	4.4(n/a)	4.3(n/a)	3.8(n/a)	4.3(n/a)
Neurologist Y (OTT)	4.0(n/a)	4.0(n/a)	4.4(n/a)	4.0(n/a)	4.0(n/a)	5.0(n/a)
Clin.neurophys.technician Z (ETT)	3.4(n/a)	3,3(n/a)	4.0(n/a)	3.3(n/a)	3.0(n/a)	3.7(n/a)
Clin.neurophys.technician Z (OTT)	4.0(n/a)	3.4(n/a)	3.8(n/a)	3.5(n/a)	3.4(n/a)	4.3(n/a)

TC = teamwork climate; SC = safety climate; JS = job satisfaction; SR = stress recognition; PoM = perceptions of management; WC = working conditions.

ETT = Endovascular Treatment Team; OTT = Open Treatment Team; n/a = not applicable; Non-physicians = all non-physician's, i.e. nurses, technicians etc.





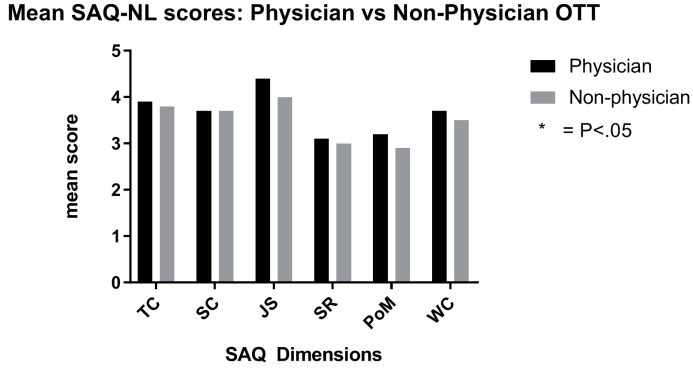


Figure 2. SAQ-NL mean scores per team and professional position.

Legend figure 2: TC: Teamwork Climate, SC: Safety Climate, JS: Job Satisfaction, SR: Stress Recognition, PoM: Perceptions of Management, WC: Working Climate

Mean Safety Attitudes Questionnaire-NL scores: physician vs non-physicians (ETT vs OTT)

Univariate ANOVA showed that for the ETT, there are significant differences between physician and non-physicians on mean scores for the SC, JS and WC domain; physicians were significantly more positive about safety climate, job satisfaction and working conditions compared to non-physicians.

Respectively, SC, JS and WC mean scores for physicians vs non-physicians were; 3.9±0.34 vs 3.4±0.35 (*P*=.002), 4.4±0.33 vs 3.8±0.41(*P*=.001) and 3.9±0.37 vs 3.2±0.68 (*P*=.008), figure 2. For the ETT, the specialist supplier did not score significantly different from the other non-physicians (table 3); there was a slight trend towards higher TC (P=.08) and SC (P=.07) scores. For the OTT, besides a slight trend towards higher mean scores in physicians for the JS domain (3.7±0.83 vs 3.5±0.54, *P*=.12), no significant differences between physicians and non-physicians scores for all domains were found.

Mean Safety Attitudes Questionnaire-NL scores: department differences (ETT vs OTT)

Univariate ANOVA and independent *t* tests showed no statistical differences between members of different departments (i.e. radiology, surgery, neurology, industry and anesthesiology) in the ETT and OTT.

Mean Safety Attitudes Questionnaire-NL scores sub-analysis: overlapping team members

Three physicians and one technician filled out both the ETT and OTT questionnaires. These mean SAQ-NL scores are also shown in table 3 (overlapping members). An independent *t* test showed no significant differences between the ETT and OTT for any of the SAQ-NL domains in this group. Despite a slight trend towards lower job satisfaction in non-physicians (*P*=.18), no significant differences were found for all domains comparing physicians and non-physicians in ETT and OTT both through univariate ANOVA. When eliminating these four participants from the total ETT and OTT physician vs non-physicians analysis, univariate ANOVA showed identical results for the ETT; safety climate(P<.002), job satisfaction(P<.001) and working climate(P<.008) mean scores were significantly lower in non-physicians than physicians in the ETT but not in the OTT.

Open Ended Questions

Of the ETT, 21(91%) respondents together provided 50 comments. Of the OTT 7(53%) respondents together provided 14 comments. For the ETT, 5 themes were identified through content analysis; comments related to peri-procedural planning, dynamics during procedures (technical, non-technical aspects), facilities present in the OR and patient privacy (multimedia appendix 3). In total 23 out of 50(46%) comments were related to teamwork between non-physicians and physicians.

Non-physicians expressed their desire to be more involved in the surgical process (12 out of 23(53%) comments); individual examples were: '*...more open communication about the patients' status during surgery' , '... more clarification of the surgical steps taken'* or *'... more debriefing after performed surgery'.*

Physicians found education of non-physicians an important issue (10 out of 23(43%) comments), individual examples were: '*… more time for extra training', '... more team members should attend the conjoined pre-surgery meetings', '…there should be more post-surgery evaluations together' and '... more open communication at different stages in surgery should be applied towards all*'. Additionally, the need for a hybrid operating room (fit for both open and endovascular treatment) was stressed (11 out of 50(22%) comments); *"...a hybrid OR where all the radiology and surgery devices are available is a must'.*

For the OTT, 2 major themes were identified; comments related to peri-procedural planning and dynamics during procedures (non-technical aspects). In total 6 out of 14(42%) comments were education related; non-physicians wanted to be educated more (4 out of 6(67%)comments), individual examples: '*… there should be more clinical classes about this procedure done by the anesthetist and surgeons'* and '*… there should be more dedicated trainings and preparation'.*

Physicians also expressed a desire for more education of non-physicians in the different phases of surgery (2 out of 6(34%) comments), individual examples: '*... if there are lessons learned during procedures, we should conjointly evaluate them'* and *'... clinical evaluations after surgery should be evaluated with the whole team'*. An overview of relevant themes for both ETT and OTT with example remarks is added as multimedia appendix 3.

Discussion

The results of this study can be summarized as follows: (1) for the ETT, physicians are more positive about the safety climate -, job satisfaction - and working conditions than non-physicians; (2) conjoined training sessions, education and post-procedural evaluation, and a hybrid OR are important topics for future improvements for both physicians and non-physicians of the ETT; and (3) using the SAQ-NL with the addition of open ended questions is an instrumental way of assessing the safety culture and climate of two surgical teams and to propose strategies to improve this further.

The findings of our local study suggest that there is room for improvement in teamwork within the ETT. Regarding safety climate-, job satisfaction- and working climate- domains, physicians are more positive than non-physicians which is not observed in the OTT. These outcomes are specified by the answers to the open questions. Especially the remarks regarding more conjoined education on procedures and the wish for a hybrid OR give a good explanation for the lower scores on the job satisfaction- and working conditions domains, and possibly the safety climate domain within the non-physicians group. Higher safety climate, job satisfaction and working conditions scores express aspects of the overall perceptions regarding commitment to safety, the work experience and the quality of the work environment (i.e. equipment, staffing), respectively. It is striking that this was different from the OTT.

A reasonable explanation for lower job satisfaction and working conditions scores in the ETT may be that non-physicians need to operate outside of their own habitat, in an environment (the angiography suite) which they are not familiar with, and do not know as well as the OR. This setup is due to the absence of adequate radiological facilities in the OR. This condition results in non-physicians having to move large amounts of instruments and materials from the OR to the angiography suite.

Having to work outside of their familiar environment, and having to move surgical equipment is not necessary for OTT members, who operate in the OR where all materials are close at hand. Qualitative results suggest that building a hybrid OR must be prioritized to raise ETT scores to the level of OTT scores. A hybrid OR is a fully functional surgical theatre that is equipped with advanced medical imaging devices such as fixed C-arms, CT scanners or MRI scanners. These imaging devices enable complex minimally-invasive surgery as well as ‘hybrid’ procedures where minimally-invasive techniques are combined with conventional ‘open’ surgery. The perceived need for more education and adequate working conditions could also explain the lower safety climate score in non-physicians of the ETT.

For future improvements, one suggestion would be cross-functional teaching between radiology technicians and scrub nurses; a more explicit definition of roles and use of equipment ; and instruction of team members by physicians. SAQ-NL outcomes can be used after these improvements to measure the effect of these changes in working circumstances on teamwork.

Implications for Surgical Procedures

Previous studies have shown the effectiveness of using the SAQ as a measure to assess teamwork in different medical settings, largely focusing on measuring the effect of team trainings on daily work(20, 21). The SAQ-NL has not been solely used as a diagnostic tool.

Although no overall differences were found in our study between both the ETT and OTT as a whole, there were important differences within the ETT. Physicians were more positive than non-physicians. Through open ended questions, important themes for improvement of daily procedures were found. Differences between physicians and non-physicians are not new(10, 22). This is however still an important finding, especially for a large tertiary referral hospital. Our findings are not only useful for patient-facing employees, but also for team managers.

These findings stress not only the need for facilitating conjoined training and education, but also to direct this more specifically towards the needs of the employees. An example of the latter is 'slowing down during surgery', which enables team members to ask questions at certain key points during the surgery process(23).

Safety Attitudes Questionnaire-NL Outcomes

Improving healthcare team culture and teamwork safety is not straightforward, and thorough assessments of workflow and interactions between different professionals are time consuming.

While improvements are necessary, trying to change the entire healthcare system at once is doomed to fail because of the complex nature of this working environment. It's questionable what the relevance of, for instance, a national teamwork assessment is. Assessing teamwork among thousands of people having no direct interaction with each other. Therefore, as proposed by Sexton et al., it is especially important to put effort in analysis of the working environment of patient-facing employees and focus on local settings(18). Attitudinal surveys on a local (team) level can be a valuable addition to this.

The present study shows that small teams can be fruitfully assessed using the SAQ-NL. Firstly, the strength of using the SAQ-NL in small teams is that a complete response rate is more easily obtained. Secondly, the clinical implications of the study outcomes can be used immediately. For example, regarding the education-related remarks, a focus on more education during procedures can be started during the next surgery. The SAQ-NL could subsequently be used to monitor how such changes would influence a team's safety attitudes. Lastly, the SAQ-NL is a useful tool in a cross-professional setting.

Due to the intertwinement of work, the specialist supplier for example cannot be left out of the ETT analysis. The SAQ-NL in this sense is not restricted to particular professions.

Future perspectives; Human Factors and team analysis

Assessing team-processes such as safety climate through the SAQ-NL, is a valuable addition to team analysis. A recent meta-analysis by Schmutz et al assessed the impact of team process-analysis on team performance(24). It showed that teams who are aware of processes during daily work, were almost 3 times more likely to achieve high performance than teams who were not. In line with this meta-analysis and as we hypothesized, we recognize the SAQ-NL as a valuable diagnostic tool for team process analysis. Mainly to assess and create awareness of processes among team members that define their daily work.

With the knowledge of what needs attention during daily teamwork, a next step could be Human Factors (HF) trainings such as Crew Resource Management (CRM) or Team Strategies and Tools to Enhance Performance and Patient Safety (TeamSTEPPS)(25). Both are proven to be effective in altering team performance through HF principles. They teach participants that people have certain strengths and weaknesses which can impact daily work in a good or bad way(16, 26-28).

The SAQ is often used to monitor the effects of these HF-training. O'Dea et al. proposed in their meta-analysis that, while plausible, it is difficult to unambiguously link changes in team behaviour or SAQ-outcomes to a particular training(29). Starting with a diagnostic approach with the SAQ of what needs attention in a team before commencing training however, the effect of CRM or TeamSTEPPS could be understood better during the course of training. For our sample, a CRM or TeamSTEPPS training could aim at improving communication during crucial steps of the ETT procedures, in order to assure shared understanding between physicians and non-physicians and hereby increase the safety climate.

Limitations

Our study has several limitations. Firstly, it is debatable what the (clinical) meaning/ implication is of the difference between sections of the Likert scale in daily work. When looking at the ETT outcomes between non-physicians and physicians for example, the difference (Δ) for the job satisfaction domain is 0.6 and working conditions 0.7. What this (statistically significant) difference implies solely from the questionnaire's outcome, is not directly clear. However, using open ended questions helps understand this difference. Secondly, we are well aware that there is overlap in respondents filling out the SAQ-NL for both ETT and OTT.

In this small group no differences were found between physicians and non-physicians for both ETT and OTT. Correcting all data for this group did not alter the main outcomes. Thirdly, the original SAQ and SAQ-NL showed good psychometric properties and a good reliability (average Cronbach's alpha of .76). In our study the reliability was generally acceptable ($\alpha \geq .70$) with the exception of the teamwork climate- domain which had a rather poor internal reliability ($\alpha = .58$). This is however highly dependent on the number of subjects participating in the study and the number of items per dimension. Further use of the SAQ-NL and research in this setting should be stressed to evaluate the psychometric properties of the SAQ-NL.

Conclusion

Non-physicians of a local team performing endovascular aortic aneurysm surgery perceive safety climate; job satisfaction; and working conditions less positively than physicians on the same team. Open ended questions specified this to be related to a lack of adequate conjoined training; education; and an adequate operating room. The SAQ-NL can be a first step in developing strategies to improve quality of care.

Contributions

ADH and JvS conceived of the presented idea. JvS provided input from earlier study of the ETT(15), ADH, AAK and JvS developed the theory, ADH performed the data collection and analysis. AAK, MJS and JvS supervised the research and critically reviewed the findings. ADH and JvS drafted the manuscript. All authors discussed the results and contributed to the final manuscript.

Conflict of interest

None.

Disclosures

None.

Multimedia appendix 1. Typical ETT procedure day.

ETT procedure day	
0730hours	Preparation angiosuite • Radiology material collection from angiosuite supply room (radiology assistant) • Surgery material collection. Moving material from OR to angiosuite (scrub nurse) • Anesthesia material collection. Moving material from OR to angiosuite (anesthesiological team)
0745hours	Technical briefing/material check (interventional radiologist, vascular surgeon, radiology assistant, anesthesiologist, scrub nurse, supplier specialist)
0815hours	Patient briefing in angiosuite (Patient, interventional radiologist, vascular surgeon, radiology assistant, anesthesiologist, scrub nurse, clinical neurophysiologist)
0820hours	Start anesthesia, neuromonitoring preparation (anesthesiologist, clinical neurophysiologist)
0845hours	Surgical preparation • Radiological material (radiology assistant) • Surgical material (scrub nurse) • Sterile draping (vascular surgeon, scrub nurse, radiology assistant)
0900hours	Surgical cut-down (vascular surgeon, scrub nurse)
0915hours	Start endovascular procedure. Flexible process which might differ greatly from one procedure to another depending on patient, anatomy, stent type, technical/anesthesiological or surgical problems encountered. Usually several 'stop moments' or 'time-outs' used for team discussion where needed. (Interventional radiologist, vascular surgeon, anesthesiologist, clinical neurophysiologist, supplier specialist, scrub nurse, radiology assistant)
……	Finalization of the procedure
0015hours	Team de-briefing as wounds are closed (whole team)
0030hours	Preparing patient for transport to ICU (anesthesiological team)
0045hours	Transport to, and briefing at ICU (anesthesiologist, vascular surgeon, interventional radiologist)
0100hours	Return of surgery and anesthesia material to OR (scrub nurse, anesthesiological team)

OTT procedure day	
0730hours	Preparation operating room • Surgery material collection on site (scrub nurse) • Anesthesia material collection on site (anesthesiological team) • Perfusion material collection on site (perfusion team)
0800hours	Start anesthesia, neuromonitoring preparation (anesthesiologist, clinical neurophysiologist)
0845hours	Team briefing in OR (thoracic surgeon, vascular surgeon, anesthesiologist, scrub nurses, clinical neurophysiologist, perfusionist)
0900hours	Surgical preparation • Surgical material (scrub nurse) • Sterile draping (thoracic surgeon, vascular surgeon, scrub nurse)
0915hours	Start surgical procedure. Flexible process which might differ greatly from one procedure to another depending on patient, anatomy, technical/ anesthesiologic or surgical problems encountered. Usually several 'stop moments' or 'time-outs' used for team discussion where needed. (thoracic surgeon, vascular surgeon, anesthesiologist, perfusionist, clinical neurophysiologist, scrub nurse)
……	Finalization of the procedure
0015hours	Team de-briefing as wounds are closed (whole team)
0045hours	Preparing patient for transport to ICU (anesthesiologic team)
0100hours	Transport to, and briefing at ICU (anesthesiologist, thoracic surgeon, vascular surgeon)

"Angiosuite" = radiology depratment intervention room with primarily radiological equipment, ETT = endovascular treatment team; ICU = intensive care unit; OR = (surgical) operation room; OTT = open treatment team

Multimedia Appendix 2: Safety Attitudes Questionnaire-NL

Below the original English questions are the validated Dutch counterparts. The open question was not in the original SAQ-NL.

Teamwork climate

1. Nurse input is well received in this clinical area.
De inbreng van verpleegkundigen wordt op mijn unit op prijs gesteld.

2. In this clinical area, it is difficult to speak up if I perceive a problem with patient care.
Op mijn unit is het moeilijk om het uit te spreken als ik merk dat er een probleem is met de patiëntenzorg.

3. Disagreements in this clinical area are resolved appropriately (i.e., not *who* is right, but *what* is best for the patient).
Meningsverschillen op mijn afdeling worden op een goede manier opgelost (d.w.z. niet wie heeft er gelijk, maar wat is het beste voor de patiënt).

4. I have the support I need from other personnel to care for patients.
Ik krijg de ondersteuning die ik nodig heb van staf-artsen om voor patiënten te kunnen zorgen.

5. It is easy for personnel here to ask questions when there is something that they do not understand.
Medewerkers op mijn unit kunnen gemakkelijk vragen stellen als er iets is dat ze niet begrijpen.

6. The physicians and nurses here work together as a well-coordinated team.
De artsen en de rest van het team hebben hier een goede samenwerking.

Safety Climate

7. I would feel safe being treated here as a patient.
Als ik hier als patiënt zou worden behandeld, zou ik me veilig voelen.

8. Medical errors are handled appropriately in this clinical area.
Medische fouten worden goed afgehandeld op de afdeling.

9. I know the proper channels to direct questions regarding patient safety in this clinical area.
Ik weet aan wie ik vragen kan stellen als het gaat om de patiëntveiligheid op de afdeling waar ik werk.

10. I receive appropriate feedback about my performance.
Ik krijg goede feedback op mijn functioneren.

11. In this clinical area, it is difficult to discuss errors.
Op de unit waar ik werk is het lastig om fouten te bespreken.

12. I am encouraged by my colleagues to report any patient safety concerns I may have.
Ik word door mijn collega's aangemoedigd al mijn bedenkingen wat patiëntveiligheid betreft te melden.

13. The culture in this clinical area makes it easy to learn from the errors of others.
De cultuur op mijn unit maakt het makkelijk om van fouten van anderen te leren.

Job Satisfaction

14. I like my job.
Ik ben enthousiast over mijn baan.

15. Working here is like being part of a large family.
Het werken in dit ziekenhuis voelt als deel uit maken van een grote familie.

16. This is a good place to work.
Dit ziekenhuis is een goede plek om te werken.

17. I am proud to work in this clinical area.
Ik ben trots dit ik in dit ziekenhuis werk.

18. Morale in this clinical area is high.
Het moreel op deze afdeling is hoog.

Stress Recognition

19. When my workload becomes excessive, my performance is impaired.
Wanneer mijn werkdruk te hoog wordt, dan lijdt mijn functioneren daaronder.

20. I am less effective at work when fatigued.
Als ik vermoeid ben dan verricht ik routinetaken minder goed.

21. I am more likely to make errors in tense or hostile situations.
Ik ben meer geneigd om fouten te maken in een gespannen of bedreigende situatie.

22. Fatigue impairs my performance during emergency situations.
Vermoeidheid hindert mijn functioneren tijdens acute situaties.

Perceptions of management
23. Management supports my daily efforts.
Het ziekenhuismanagement helpt me bij mijn dagelijkse bezigheden.

24. Management doesn't knowingly compromise patient safety.
Het ziekenhuismanagement brengt de veiligheid van de patiënten niet bewust in gevaar.

25. Problem personnel are dealt with constructively by our unit / hospital management.
Dit ziekenhuis gaat constructief om met minder goed functionerend personeel.

26. I get adequate, timely info about events that might affect my work, from unit / hospital management.
Ik krijg voldoende, tijdige informatie over gebeurtenissen in het ziekenhuis die invloed kunnen hebben op mijn werk.

27. The levels of staffing in this clinical area are sufficient to handle the number of patients.
We hebben genoeg personeel om de werklast aan te kunnen.

Working conditions
28. This hospital does a good job of training new personnel.
Dit ziekenhuis is goed in het trainen van nieuw personeel.

29. All the necessary information for diagnostic and therapeutic decisions is routinely available to me.
Ik beschik steeds over alle informatie die nodig is voor diagnostische en therapeutische beslissingen.

30. Trainees in my discipline are adequately supervised.
Degenen die opgeleid worden in mijn discipline krijgen voldoende begeleiding.

Open question
What are your top three recommendations for improving patient safety in this clinical area? (complex endovascular aortic treatment)
Wat zijn jouw top drie aanbevelingen om patiëntveiligheid te verbeteren binnen deze setting (complexe endovasculaire aortabehandelingen)

Multimedia appendix 3: Themes and open ended question answers SAQ-NL analysis ETT vs OTT.

Teams	Examples
ETT themes	
Peri procedural planning	".. sufficient numbers of scrub nurses are needed for safe procedures.." (Scrub nurse) " ..good preparation of all team members and OR-room.." (Radiology technician) " ..enough procedures should be planned to keep everyone up-to-date and well-trained."(Thoracic surgeon)
Dynamics during procedure – technical aspects	" .. monitor patient vitals more closely and keep track consistently."(Scrub nurse) "...radiology technicians and scrub nurses should teach each other the steps they undertake during the procedure..." (Scrub nurse)
Dynamics during procedure – non technical aspects	"...keep track of the steps that are taken during the procedure and discuss what happens next."(Clinical neurophysiological technician) ".. there should be more conjoint post-discussions on the procedure.." (Vascular surgeon)
Facilities of surgical theatre	"..a hybrid OR where all the radiology and surgery devices are available is a must.." (Vascular surgeon, scrub nurse, radiology technician, radiologist)
Patient privacy	"..availability of patient data to non-medical personnel/ industry is hampered by modern Dutch law.." (Specialist supplier)
OTT themes	
Peri-procedural planning	"... sometimes it's difficult to plan all the waiting patients.." (Vascular surgeon) " .. there should be a limited number of surgeons at the table.." (Perfusionist) ".. we should facilitate spectators from other specialities.." (Vascular surgeon) "..we should gather post-operative problems and discuss them more.." (Anesthesist) "..there should be more procedures to keep our skills up-to-date." (Thoracic surgeon)
Dynamics during procedure – non technical aspects	".. there should be a limited number of surgeons at the table to streamline communications.." (Perfusionist) ".. education on surgical steps for nurses should be mandatory.." (Scrub nurse) "..ICU personnel should be educated on these procedures as well.."(Vascular surgeon) "..we should do proper introductions of all team members present before the procedure starts.." (Scrub nurse)

Definitions of themes:

Peri procedural planning - all work involved around the surgical procedure including preparation and discharge of the patient, but also preparation of materials etc.

Dynamics during procedure – technical aspects – all steps involved during the procedure that encompass use of equipment (surgical, radiological, neurophysiological) within the OR during the procedure (ETT or OTT).

Dynamics during procedure – non technical aspects – all steps involved during the procedure that encompass communication between team members within the OR during the procedure (ETT or OTT).

Facilities of surgical theatre – all aspects of the operating theatre that support functionality (like quick access to equipment) during procedures (ETT or OTT).

Patient privacy – all aspects of correct and safe use of patient medical data in line with Dutch law, for example patient rights, safe storage of data and availability of data to third parties.

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