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The Surgical Hazardous Attitudes Reflection Profile (SHARP) Instrument – A Prototype Study

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ABSTRACT

OBJECTIVE There is growing recognition that surgeons' non-technical skills are crucial in guaranteeing optimal quality and safety of patient care. However, insight in relevant attitudes underlying these behavioral skills is lacking. Hazardous attitudes potentially cause risky behavior, which can result in medical errors and adverse events. A questionnaire offering surgeons insight in their attitudinal profile is still missing and would be instrumental in risk reduction. Therefore, the aim of this study is to develop a prototype of a reliable and valid instrument to measure hazardous attitudes among surgeons.

DESIGN To measure hazardous attitudes, a prototype of the Surgical Hazardous Attitudes Reflection Profile (SHARP) tool was designed using a mixed methods approach, consisting of (1) two focus group discussions, (2) a modified Delphi analysis and (3) a survey followed by (4) statistical analysis of the psychometric properties. Statistical analysis included exploratory factor analysis with varimax rotation, calculation of internal consistency reliability coefficients and inter-scale correlations.

SETTING 14 hospitals across the Netherlands were recruited to guarantee demographic variety and the inclusion of academic, tertiary and general hospitals.

PARTICIPANTS Nineteen experts participated in the two focus groups, and 19 in the modified Delphi study. In total, 302 surgeons (54.1%) completed the SHARP.

RESULTS In total, 302 surgeons (54.1%) completed the SHARP. Exploratory factor analysis resulted in six subscales measuring attitude towards (1) authority (α=0,78), (2) self-performance (α=0,69), (3) performance feedback (α=0,61), (4) own fitness to perform (α=0,54), (5) uncertainty (α=0,51), and (6) planned procedures (α=0,48).

CONCLUSIONS This study resulted in a prototype instrument identifying six potential hazardous attitudes in surgeons. Attitudes towards "authority" and "self-performance" can now be validly and reliably measured. Further research is required to optimize the prototype version of the instrument and could usefully explore the plausible relations between hazardous attitudes and clinical outcomes.

Word count: 294

INTRODUCTION

The complexity of surgical care combined with the inherent limitations of human performance – even in skilled, experienced, highly motivated professionals – ensures the occurrence of adverse events[1,2]. The quality of surgical care is, apart from system factors, highly dependent on the professional performance of health care professionals[3,4]. In the surgical setting, safe performance relies on the ability of the surgical team members to combine professional knowledge and technical expertise with non-technical skills[2,5]. Previous studies have revealed the pivotal role of communication, teamwork and situational awareness in providing safe and effective surgical care and in minimizing the number of technical and non-technical errors[6-9]. Specifically, the cognitive non-technical skills, decision-making and situational awareness, have been proven to correlate with performance[10]. Research has shown that non-technical skills are affected by surgeons' professional attitudes[11-13]. Furthermore, existing research recognises that a significant percentage of adverse events are related to the peri-operative process[24]. These findings justify a closer look at hazardous attitudes in surgeons which potentially contribute to medical errors, adverse events and unsafe working conditions.

The relevance of professional attitudes has been studied extensively in aviation, showing that hazardous attitudes might negatively influence the professional performance of pilots[14-16]. According to the Federal Aviation Administration (FAA) an attitude is defined as a personal motivational predisposition to respond to persons, situations or events in a given manner[17]. The FAA identified five hazardous attitudes: macho, impulsive, anti-authorian, resignation and invulnerability[17,18]. A study investigating hazardous attitudes in college-aged drivers revealed a sixth hazardous attitude: too high levels of self-confidence[19]. As attitudes influence how people make decisions, awareness of these six hazardous attitudes is found to be useful for the prevention of aviation accidents[16, 20]. As a result, pilots are now trained to recognize and counteract these hazardous attitudes[17,18].

In surgery, an American study involving a sample of 364 orthopedic surgeons illuminated that thirty-eight per cent of the orthopedic surgeons studied, reported at least one hazardous attitude[21]. Furthermore, research findings indicated that the hazardous attitude labelled as 'macho' is related to an increase of readmission and reoperation rates[22]. However, these results were generated by using a hazardous attitudes questionnaire developed and validated for pilots, not for use by surgeons[21,22]. A validated questionnaire measuring surgeons' hazardous attitudes is now unavailable.

As a first step in a formative process of reflecting and adapting one's professional performance, insight obtained from a validated questionnaire focusing on surgical professions may be beneficial for both surgical faculty and residents. Increasing awareness about one's attitudinal profile could further optimize surgeons' (non-)technical performance, and ultimately patient outcomes[24]. We do acknowledge the highly complex phenomenon of hazardous attitudes in surgical care settings and the related challenge of translating the concept into a valid and usable tool in clinical practice. This study is the first step in a multi-phase trajectory, aiming to develop a prototype instrument on hazardous attitudes in the context of surgical care.

MATERIAL AND METHODS

Design

We used the existing Hazardous Attitudes Inventory Test (HAS) as a starting point for the development of a measurement tool of surgeons' hazardous attitudes. The HAS was originally developed and validated for pilots by the Federal Aviation Administration and the Canadian Air Transport Administration[25], and used before to measure hazardous attitudes in surgeons[21-22]. A validation process for the surgical profession is still missing[21,22].Therefore, we first conducted focus group discussions to explore the phenomenon of hazardous attitudes, including review of the original HAS items. Second, we performed a modified Delphi analysis on both the original HAS items and newly collected topics and items in order to develop a prototype instrument measuring hazardous attitudes in surgeons: the Surgical Hazardous Attitudes Reflection Profile (SHARP). Finally, we pilot-tested the prototype of the SHARP in the surgical setting in the Netherlands.

Focus group sessions

The purpose of the focus group discussions was to explore the phenomenon of hazardous attitudes among surgeons, and reflect on the proposed hazardous attitudes in the existing HAS questionnaire[26]. Two focus group sessions at two university medical centers were organized. All focus group participants were purposefully selected using the extensive network of the research group members. To obtain a broad professional perspective on the subject, the focus groups consisted respectively of 9 and 10 experts from different backgrounds: surgeons (cardiothoracic, trauma, orthopedic, neurosurgery, gynecology and oncology), medical specialists (pulmonologist, general practice, intensive care), operation room assistants, nurses and other health care professionals (medical lawyers, complaint officers). Apart from surgeons, specialists from other backgrounds working with surgeons in daily care were included to guarantee a broad and objective view on relevant hazardous attitudes in the surgical population. Additionally, diversity in sex, years of experience and hospital type were included as selection criteria. Participants received an e-mail informing them about the aim of the research and time, date and location of the focus group discussion. The focus group discussions were led by an experienced moderator (EH or KL), observed by one researcher (KD), audio-recorded and transcribed verbatim. A focus group protocol was available to guide the discussions.

At the start of the session participants were asked to give their consent for the use of the data for publication. All participants consented. The moderator introduced the predefined questions, which were also presented on a screen, and stimulated the participants to share their personal

experiences. The discussion started with an open exploration of characteristics of possible hazardous attitudes among medical doctors and was further specified into surgeons. This was followed by a discussion on the six predefined hazardous attitudes defined for pilots (macho, antiauthority, impulsive, resignation, invulnerability and self-confidence). Focus group participants were asked to reflect on the applicability and definition clarity of the six attitudes for medical doctors. Furthermore, participants were stimulated to exemplify observations of these attitudes as presented by surgeons in daily practice. Lastly, participants were invited to reflect on the degree to which the six predefined hazardous attitudes provided a complete overview on possible hazardous attitudes of medical doctors. The transcriptions of the focus group sessions were analyzed by one researcher (KD) using a deductive qualitative coding approach. This coding process was verified by the research team in a two-step discussion and verification process (first by KL and then by EH and RS). As a result, the transcriptions combined with the existing literature served as a basis for the research group to supplement the HAS questionnaire with newly formulated SHARP items to be further evaluated in the Delphi-round. Additionally, based on the focus groups, the research team discussed the clarity and relevance of the original items of the HAS questionnaire for surgical practice, and removed inadequate items.

Delphi round and analysis

To collect feedback and achieve consensus on the SHARP items, the 19 focus group members and 14 members of the Board of the Dutch Association of Surgery were invited to participate in a modified Delphi round[27,28]. This procedure is intended to achieve consensus among experts about items generated by themselves in a systematic manner[27, 29]. A modified Delphi implies that items were selected based on previous research and/or by experts – as in this study the research team – who were not involved in the Delphi round themselves[17,21,28]. Participation in the modified Delphi round was voluntary. Respondents were asked to score each item on two criteria: (1) how relevant is this item to measure hazardous attitudes in medical practice? (2) how unambiguous is this item formulated? The second criteria was included since an extensive part of the SHARP items were newly formulated items and the HAS items were validated for use by pilots, not surgeons.

Items could be rated on a 4-point scale from 1 ‘being not relevant/clear at all’ until 4 ‘being highly relevant/clear’. Furthermore, every respondent was asked to indicate the 10 items that could be omitted from the list and the 10 items that deserved the highest priority.

Respondents’ answers were analyzed by calculating the mean scores on relevance and clarity.

These scores were then plotted and inspected visually, both per expert subgroup (doctors and other health care professionals) and for all experts combined. Based on the visual inspection, items that showed consistently low relevance or clarity scores were excluded. The threshold for exclusion of items was set at ≤2,43 for relevance and/or ≤3,10 for clarity, based on an average score of 2,76 (SD 0,33) for relevance and an average score of 3,38 (SD 0,28) for clarity. We consciously decided not to include very narrow cut-off levels at this stage of the questionnaire development to remain a decent sample of items in the pilot-testing phase. Acknowledging the prototype stage of the questionnaire, we could in this way include both the outcomes of the Delphi- and statistical analyses in our final decision to exclude items. The remaining items were extensively discussed within the research team. The prioritizing process of the items that was performed by the Delphi round participants was used as an important indicator for the research group's final choice of items to be included in the initial SHARP instrument. In the Delphi round items were provided and reactions were given in Dutch. All SHARP items were translated by a native speaker using the appropriate forward backward translation procedures for pilot-testing purposes[30].

Pilot-testing the SHARP

Data collection

An internet-based environment was developed to enable data collection for testing the SHARP. For successful data collection, we first sought commitment by recruiting research ambassadors: one surgeon per hospital who was willing to introduce and emphasize the relevance of the study at hand with the surgical specialists in his or her hospital, and request their participation. In total, 14 ambassadors in 14 hospitals across the Netherlands were recruited by using the network of the research team. Demographic variety and the inclusion of academic, tertiary and general hospitals were guaranteed. This contributed to an inclusive and representative sample of surgeons. A letter explaining the context of the research, the developmental phase of the SHARP instrument and the web-link to the questionnaire was sent to the ambassadors of the 14 hospitals by email. The ambassadors formalized the letter to fit their specific hospital lay-out and sent it to all the hospital-based surgeons, including the following subspecialties: cardiothoracic surgery, otorhinolaryngology, general surgery, neurosurgery, gynecology and obstetrics, plastic surgery, orthopedic surgery and urology.

From March 2017 until April 2017, the questionnaire was offered to 558 surgeons in 14 hospitals in the Netherlands. The respondents were asked to indicate their level of agreement with the statements in the SHARP questionnaire using a five-point likert-response scale from 1

("strongly agree") to 5 ("strongly disagree"). Additionally, we inquired demographic information about sex, age, year of graduation, type of hospital and sub specialty. Respondents were provided a three-week time-slot to reply. After one week a reminder was sent by email by the ambassadors. Hospitals that had not proceeded yet to dispatch the questionnaire were actively encouraged by telephone to accelerate the process of data collection.

Statistical Analysis

We performed several statistical analyses to explore the validity and reliability of the SHARP instrument[3,4,29,31]. First, the study sample was described using appropriate statistics. Second, the median, 20_{th} and 80_{th} percentile scores of all items were calculated to inspect for extreme floor or ceiling effects. Third, we conducted exploratory factor analysis by performing principal axis factor analysis with varimax rotation on all HAS and newly formulated SHARP items[32]. Exploratory factor analysis is an appropriate statistical method to extract a reduced set of underlying factors or constructs from a larger set of items (questions). Based on the outcomes of this analysis, the different items are grouped into factors or subscales and reflect a specific (named by the research team) hazardous attitude. The combination of the five subscales results in the total questionnaire scale (in this case the SHARP). In addition, exploratory factor analysis was performed separately for the 7-item subscale on reflective communication of the validated Groningen Reflection Ability Scale (GRAS) - questionnaire, which was added to the total item pool based on the focus group discussions and Delphi-round The exploratory nature of this study, the heterogeneous study sample and the combination of the non-validated HAS items and the newly formulated items, supported the use of the exploratory factor analysis as the most suitable choice. We used the Kaiser-Guttman criterion (Eigenvalue>1) to decide on the number of factors to extract[33]. We also checked the scree plot to verify the most comprehensive number of factors underlying the SHARP items. One-item factors were excluded. The interpretation of the factors was led by the factor loadings > 0.40 and the meaningfulness of the factors in relation to the theory. When these two aspects were conflicting, theory was leading because of the exploratory nature of the study and the number of newly formulated items. The allocation of each item to the right factor was further discussed within the research group.

In terms of consistency and reliability measurements of the SHARP instrument we first computed the corrected item- to scale correlations (satisfactory if > 0.30) for each item. Second, we checked for overlap between the scales by calculating the inter-scale correlations

(satisfactory if < 0.70). Third, we examined internal consistency of the final scale by calculating Cronbach's alpha coefficients. A Cronbach's alpha of 0.70 was considered as satisfactory reliability, a coefficient of 0.80 was considered as good reliability[34]. Finally, we computed the internal consistency, factor loadings, and item to scale correlations of the GRAS-items for the surgical population separately.

ETHICS STATEMENT

The institutional ethical review board of the Academic Medical Centre of the University of Groningen (UMCG) waived ethical approval for this study. All information obtained during the focus group sessions and Delphi round was processed anonymously and informed consent was signed by all participants. During the pilot-testing phase, respondents were again informed about the anonymous and confidential management of the data. Furthermore, it was emphasized that respondent's answers were only used for validation purposes, not focused yet on analyzing their own personal (hazardous) attitudinal profile.

RESULTS

Questionnaire Development Process

From the initial 57 items collected based on the HAS questionnaire, literature and focus group sessions, 44 items were pilot-tested in the surgical setting after the Delphi procedure. This resulted in a first prototype version of the SHARP tool consisting of 6 scales, including 25 items. A schematic overview of the whole developmental process is illustrated in Figure 1 and every step will be discussed below.

Focus groups

The open exploration of characteristics of possible hazardous attitudes in surgeons revealed "arrogance", "impatience" and "inability to provide or receive feedback" as the most commonly potential hazardous attitudes visible in daily practice. The attitudes "arrogance" and "impatience" were evaluated to conceptually fit the existing hazardous attitudes and were therefore not added as new hazardous attitudes. Agreement among all focus group discussion participants was accomplished to add a new (seventh) hazardous attitude: lack of the ability to provide and/or receive feedback. Therefore, the research group decided to add the 7-item subscale on reflective communication of the validated Groningen Reflection Ability Scale (GRAS) questionnaire, developed to measure personal reflection in medical practice and

education[4]. This specific sub-scale reflects medical students' openness to provide and receive feedback and was therefore included in the item-list of the tool to test its applicability for surgeons. From the 30 existing HAS items 27 were maintained: two items were excluded for their repetitive nature, and one item based on irrelevance to medical practice. Lastly, the list of 34 (27+7) items was supplemented with 23 newly formulated items based on the focus group sessions and review of the literature, resulting in a first draft SHARP questionnaire consisting of 57 items.

Modified Delphi round

The Delphi expert group consisted of 10 (response rate 47%) focus group members and 9 (response rate 64%) members of Board of the Dutch Association of Surgery. All experts had both experience in working in the clinical setting and advanced experience in leading positions in guaranteeing quality and safety of patient care. The expert group consisted of surgeons (from neurosurgery, cardiothoracic surgery, general surgery, trauma surgery, gynecology and orthopedic surgery), and an emergency doctor, complaint officer and medical lawyer. Based on the ratings of the 19 experts, evaluating relevance, clarity and prioritizing the statements (the strongest and weakest 10 statements were indicated), 13 out of the initial 57 items were excluded. Two of these items were excluded based on a mean clarity ≤ 3.10, five items based on a mean relevance of ≤ 2.43 and five due to both a mean clarity ≤ 3.10 and a mean relevance ≤ 2.43. In addition, the statements that revealed a mean clarity ≤ 3.10 or mean relevance ≤ 2.43 were placed among the weakest 10 in the prioritizing process by the participants, which supported the exclusion of the items. Finally, the research group discussed these results and decided to exclude one other item that was suggested by five participants to be removed from the list. In addition, four items that showed moderate scores on relevance to medical practice were maintained in the initial questionnaire, to create the opportunity to re-evaluate these items after the pilot-testing phase. Consequently, 44 items were maintained in the preliminary SHARP instrument to be pilot-tested in surgical practice (see table 1).

Ultimately, the total item pool of 44 items consisted of 20 items from the original HAS questionnaire, 18 new items based on focus group discussions and the literature and 6 items from the original GRAS questionnaire.

Testing the SHARP

In total, 307 (response rate 54.2%) surgeons participated in pilot-testing the SHARP questionnaire. Five questionnaires were excluded from the analysis because the questionnaire

was filled out incompletely. In total, 302 questionnaires were available for analysis. Of the respondents, 215 (69.6%) were male and 87 (28.2%) female. The mean age of the respondents was 47.2 years and the mean years of experience was 22.4 years. Of all participants, 89 surgeons (29.9%) were working in a university medical center, 180 (58.6%) in a tertiary center and 33 (11.4%) in a general hospital. All surgical subspecialties were represented, the largest group being general surgery (30.1%) and the smallest group cardiothoracic surgery (4.9%) (see table 2).

Statistical Analysis

Exploratory factor analysis was performed on a total of 38 items (GRAS item loadings were calculated separately) and revealed an initial nine-factor structure of the SHARP instrument. The scree plot demonstrated a clear cut-off point at five factors. Five factors showed adequate factor loadings and conformity to theory. Three single-item-factors and one two-item-factor were excluded from the questionnaire. Three items showed cross loadings. One of these items was removed from the list, as no adequate fit to one of the factors was possible. The two other items were placed in the most suitable factor based on existing literature. The item "While performing risky operations, I worry about not identifying landmarks and losing the overview" was maintained as a single item in one factor, and therefore moved to the factor of best suitable fit based on relevant and corresponding theory. The prototype of the SHARP then included five factors.

Subsequently, we assigned labels to these five factors. These factors – representing the hazardous attitudes – were based on elaborate discussion within the research team, literature on hazardous attitudes, and discussions during the focus group. As the five attitudes are assumed to be hazardous in their extreme endings, we chose a neutral wording for every factor, resulting in: attitude towards (1) authority, (2) self-performance, (3) own fitness to perform, (4) uncertainty and (5) planned procedures. An overview of all hazardous attitudes, their definitions and ways to counteract them (antidotes) is illustrated in table 6. The first factor consisted of five items reflecting the subscale "attitude towards authority" (e.g. "Reporting incidents or calamities is of minimal added value", "The hygiene rules in the hospital are totally right"), showing adequate factor loadings and an acceptable Cronbach's alpha of 0.78 (table 3 and 4). The second factor (four items) portrayed the sub-scale "attitude towards self-performance" (e.g. "I only like to perform very challenging operations", "I perform above average in my professional group"), demonstrating adequate factor loadings and an acceptable Cronbach's

alpha of 0.69 (table 3 and 4). The third (three items), fourth (four items) and fifth factor (two items) involved the sub-scales “attitude towards own fitness to perform”, “attitude towards uncertainty” and “attitude towards planned procedures” respectively. These factors showed adequate factor loadings, however revealed moderate to poor internal consistency scores, 0,54, 0,51, and 0,48 respectively (table 3 and 4). Although the fifth factor only contained 2 items, the research team evaluated the scale as relevant for surgical practice and suitable to maintain in this prototype version of the SHARP. The item to scale correlations of all five factors were above 0.3 (table 3 and 4). The inter-scale correlations revealed satisfactory overlap between the scales and ranged from -0,314 to 0,317 (table 5).

Lastly, we found the internal consistency of the reflective communication scale of the GRAS-questionnaire (e.g. “I do not welcome remarks about my individual performance”, “I am open to discussion about my opinion”) to have an alpha of 0.61, factor loadings > 0.4 except for one item, and satisfactory item to scale correlations (see table 3 and 4).

DISCUSSION

Main findings

This study reports how, by applying a mixed methods approach in three successive phases, a first prototype of the SHARP instrument was developed to measure surgeons' hazardous attitudes. This prototype instrument now consists of 6 potential risk-related attitudes of which the psychometric qualities vary from good to poor. Existing literature, the focus groups and Delphi-round confirmed the revealed attitudes and were taken into consideration in the design of the final prototype. Methodological and theoretical reflections will be further discussed in this section.

Explanation of findings

The first scale representing "attitude towards authority" reflects whether surgeons acknowledge and act according to existing rules, regulations and agreements. A study assessing operating room staff compliance with clothing regulations and traffic flow during surgical regulations revealed that only 56% respected all regulations[35]. In turn these inappropriate staff behaviors can lead to environmental contamination of the operating room and subsequent surgical site infection[36]. The relevance of this attitude in surgeons is also acknowledged in relation to the occurrence of adverse events in the peri-operative process. Specifically, the adequate completion of comprehensive checklists was associated with a reduced amount of surgical complications and mortality rates[24]. On the contrary, it has been reported that hospitals' consistent compliance with guidelines to prevent wrong surgery needs to be improved, and that behavior shaping mechanisms to realize this needs to be further optimized[37,38]. Consequently, "attitude towards authority" as a potential hazardous attitude could be viewed as an important inclusion factor in educating surgeons throughout their career in quality and safety of patient care.

The next hazardous attitude in surgeons in this study "attitude towards self-performance" is supported by literature showing that a significant percentage of orthopedic surgeons have a macho attitude[21]. A macho attitude can be interpreted as an overestimation of self-performance, and has been proven to contribute to higher reoperation and readmission rates[21,22]. An overestimation of one's self-performance effects the decision-making process, which has been proven to be a relevant non-technical skill that influences critical task performance in surgeons[10]. Therefore, evaluating surgeons' attitude towards self-

performance may offer them new personal insights to be taken seriously in terms of their decision-making process in providing surgical care. Their increased attitudinal awareness towards self-performance may result in more appropriate decisions and thus, ultimately, contribute to improved health care outcomes. Furthermore, the impact of surgeons' attitude towards self-performance on learning strategy and - outcomes can be further investigated.

The next hazardous attitude "attitude towards performance feedback" has been confirmed to be relevant in surgical practice. Supportively, this has been emphasized as an important factor in terms of commitment to professionalism in medicine[3]. Moreover, "the ability to provide and receive feedback" has been put forward as an indispensable aspect to be embedded in medical education[4]. However, this scale showed a moderate internal consistency, which could be explained by the fact that the questionnaire was originally developed for medical students. Further optimization of this scale through expert panel sessions or Delphi-rounds would be instrumental in adapting the items towards the surgical context.

As medicine is a science of uncertainty and an art of probability, uncertainty pervades and motivates the majority of activities related to health care[39]. As causal uncertainty applies to and motivates judgment and decision making, it will affect surgeons' performance in daily care and in risky situations in particular[40]. Therefore, the scale reflecting "attitude towards uncertainty" will be relevant in creating awareness about potential hazardous decision-making processes. Although the psychometric properties of this scale are still suboptimal, the scale was maintained based on the high relevance to surgical practice.

Future research could use individual interviews to further explore the last three scales of the prototype of the SHARP instrument. These in-depth interviews could yield a more concrete and specific picture of the attitudes and behaviors displayed by the workforce, and therefore generate valuable input for (re)formulating items. Moreover, situational judgement tests have been proven to be a valid, reliable and well-conceived method for measuring important non-technical skills, such as communication and teamwork[41]. Performing these tests to assess surgeons' reactions to several hypothetical role-relevant scenarios based on detailed analysis of their role and developed in collaboration with surgeons, will reveal relevant aspects about hazardous attitudes associated with professional performance. These results could provide more insight in the relevant hazardous attitudes and reveal important input to rephrase or initiate adequate items to be included in the SHARP questionnaire.

Further statistical analysis revealed two more findings to reflect on: the relatively small range and low standard deviation of the scales. One explanation of the relatively small range could be the phrasing of the items. Although we invested in a thorough development of the items, we may not have been able to formulate items that best reflect the intended hazardous attitudes or behaviors. A second explanation of the relatively small range could be the self-reporting nature of the questionnaire which resulted in respondents being inclined to give socially desirable answers in filling out the SHARP. Socially desirable reporting is generally higher in situations in which favorable self-presentation is required[42]. Being conscious of the importance of patient safety and their individual expected role modelling in patient safety behaviors, surgeons may not have felt the trust and self-safety to honestly rate all questions. However, respondents were informed that this questionnaire was not meant as a performance evaluation and that their answers were processed anonymously, which decreases socially desirable answering. Nonetheless, future research could explore whether rephrasing items would more realistically describe the intended situation and enhance neutral phrasing of items as this has been shown to decrease the degree of socially desirable answers[43].
In addition, offering the respondents a 7-point Likert scale could have facilitated a more nuanced way of answering.

The relatively low standard deviation of the scales can be interpreted as a normal finding for scales that are not normally distributed and is reported in other studies aiming at validating questionnaires[44]. Most surgeons show excellent performance and extreme hazardous attitudes are suggested to be only present in a limited sample of surgeons. For this prototype version, no cut-off points have been calculated yet.

Strengths and Limitations

We consider the three-step process in developing the prototype of the SHARP consisting of quantitative and qualitative methods and the combination of theory and practice as strengths of this study. Furthermore, we have pilot-tested the SHARP in a realistic representation of the surgical physician's population in the Netherlands by including 14 different academic, tertiary or general hospitals with adequate geographical spreading and surgeons from eight different subspecialties in the study sample. Different professional backgrounds of the focus group and Delphi-round participants, as well as the critical evaluations of the research group contributed to the systematic development of the instrument. Participants in the focus group discussions

and the Delphi round had various professional backgrounds, warranting the inclusion of different perspectives, subspecialties, years of experience and clinical settings in the critical evaluation process, which in turn contributed to a representative synthesis of the instrument items. This practice-oriented validation strategy supported a validation process that aligns with the concept of validity as a social imperative for assessment[45]. The HAS questionnaire developed for aviation was reconsidered thoroughly and appeared not to meet the requirements to measure hazardous attitudes validly and reliably in surgeons. As no other questionnaire for this purpose exists, the development of the SHARP is of high relevance for medical practice. However, the analysis in this study represents the first quantitative test of the preliminary structure that was based on a qualitative exploration. Therefore, at this stage changes and refinement are expected and desired. This study revealed 2 different attitudes that can be measured reliably and validly. The questionnaire could be further optimized to achieve higher factor loadings and internal consistency of the scales. Future research could reveal other hazardous attitudes that could be added to the SHARP. Furthermore, the "attitude towards authority" scale contains items that might need rephrasing depending on the setting in which the questionnaire will be used. The rules and regulations about 'door movements in the OR' and specific dress codes might differ in different cultural, healthcare or regulatory contexts. Lastly, the purpose of the SHARP questionnaire is to measure existing hazardous attitudes in surgeons on an individual level. To stimulate an honest reflection of these individual behaviors, other appropriate methods such as observations or 360 degrees feedback interventions could be added and reinforce the impact of this self-assessment questionnaire.

Implications

Surgical teams could evaluate the existence of hazardous attitudes by completing the SHARP questionnaire on an individual level. Consequently, awareness of these attitudes could help improve surgical performance by coaching surgeons (in training) on counteracting these aspects during their education or further career in the context of professional performance and lifelong learning. Awareness of these attitudes could inspire senior surgeons to keep on setting the right example and could support surgical residents in counteracting the socialization process in which they could unconsciously adopt these hazardous attitudes from their working environment[46]. Additionally, the SHARP could yield data on a national level in terms of differences in demographics, hospital types or surgical subspecialties concerning the existence of hazardous attitudes.

The developmental process of this prototype shows, once again, that tools developed in one setting for a specific target group, cannot easily be applied in different settings for use by another target group. This study shows how this prototype version could be further optimized. Future research should include further development of the SHARP in terms of internal validity and consistency to monitor and further improve the quality and impact of the SHARP. Finally, the development of this questionnaire was built on the general understanding that humans are fallible and thus human error exists. At no point in the development of the SHARP prototype it was challenged by the participants that attitudinal and behavioral aspects can be contributors to adverse events, and in practice actually are. As hazardous attitudes might eventually result in hazardous behavior, creating awareness on all relevant hazardous attitudes in surgeons might encourage the further decrease in adverse events, iatrogenic patient injuries and improve safe working conditions[47,48]. Subsequently, embedding the awareness of these aspects and coaching surgeons (in training) to counteract these attitudes, could be a valuable next step in stimulating the professional development of non-technical skills in surgeons.

CONCLUSION

The SHARP is a prototype instrument that validly and reliably yields data about the prevalence of surgeons' "attitude towards authority" and "attitude towards self-performance". Ongoing research into reliable measures of other hazardous attitudes is warranted. Future research could focus on the plausible correlations between hazardous attitudes and clinical outcomes. After this link has been investigated analyses on the effect of hazardous attitudes on the quality and safety of patient care can be revealed.

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TABLES AND FIGURES

Figure 1. Questionnaire Development Process

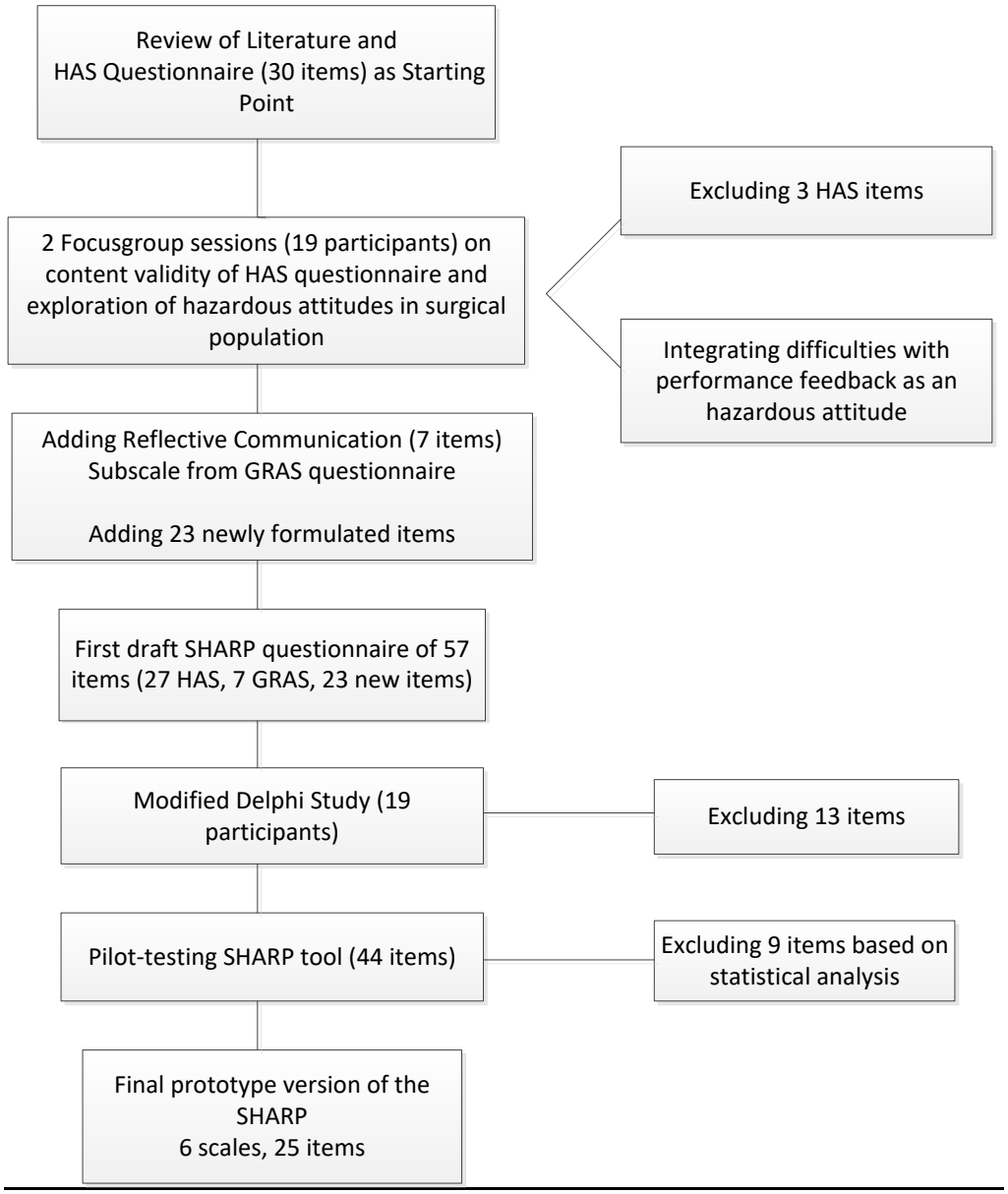

Figure 1. Questionnaire Developmental Process

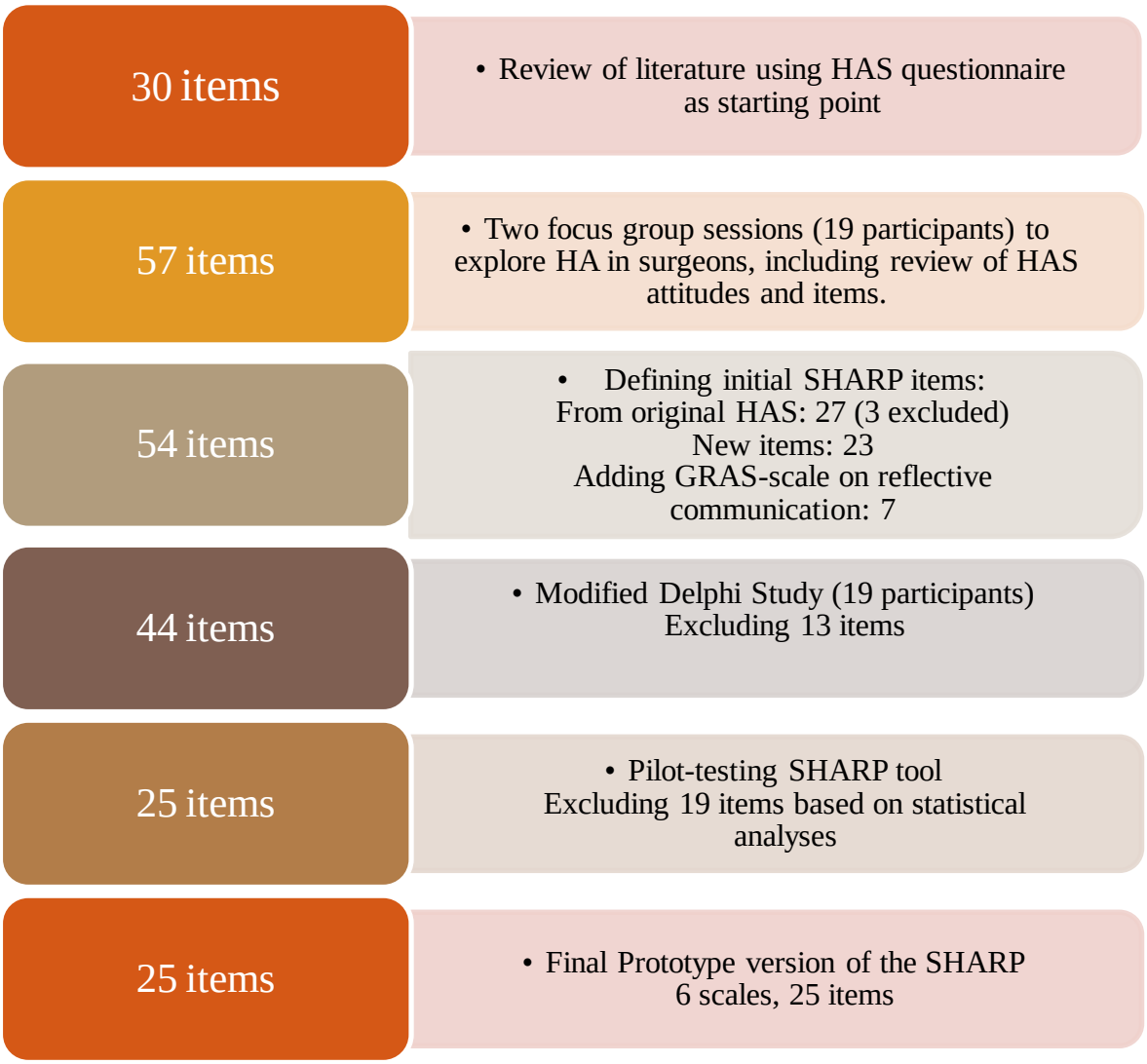

Table 1. Characteristics of the participants in the modified Delphi procedure

Background	**Amount**
Number of participants	19
Number of females	5
Number of Board Members Dutch Association of Surgery	9
Number of focus group participants	10
Number of surgeons[1]	15
Number of medical specialists[2]	2
Number of other professional working in health care[3]	2
[1] Neuro surgery, cardiothoracic surgery, general surgery, trauma surgery, orthopaedic surgery [2] gynaecologist, emergency doctor [3] complaint officer, medical lawyer	

Table 1. Results of Delphi round procedure.

Q #	**Item**	**Origin of item[1]**	**Indicated as 1 of the 10 items to be deleted[2]**	**Indicated as 1 of the best 10 items[3]**	**Relevance[4]**	**Clarity[5]**
Items that were excluded						
1	The OR planning is rather occupied limiting access to the OR than with providing services*	HAS	5	0	2.50	2.50
2	I take responsibility for what I say*	GRAS	8	2	2.83	2.94
3	If I want to operate a patient, I want to do it now**	HAS	10	0	2.28	3.44
4	I always agree with the order of procedures as determined by the OR planning**	HAS	6	0	2.11	3.00
5	The structural use of the doors at the OR in a correct manner, is not compatible with practice**	FG	7	0	2.42	3.00
6	The use of the “average operating time” is of no added value**	FG	4	0	2.33	3.11
7	A real surgeon is always busy **	FG	6	1	2.33	3.61
8	In a tight situation, I trust fate***	HAS	6	0	2.28	2.83
9	When I am in a tough spot, I figure if I make it, I make it, and if I don’t, I don’t***	HAS	6	1	2.39	2.89
10	During surgery, what will be, will be***	HAS	9	0	2.06	2.78

11	I am a surgeon entirely due to my hard work and ability***	HAS	7	1	2.42	2.94
12	Most OK rules don't serve safety****	HAS	5	0	2.72	3.44
13	It is acceptable to speak to colleagues by telephone, while performing an operation****	FG	6	0	2.61	3.28
Items included for pilot-testing in surgical practice						
14	While performing risky operations, I worry about not identifying landmarks and losing the overview	HAS	3	4	2.83	3.28
15	If the procedure is dependent on specific tools (e.g. laparoscopic camera, navigating equipment), I worry if I will reach the desired outcome if the tool functions sub optimally	HAS	2	3	3.06	3.17
16	I can learn every surgical skill if I put my mind to it.	HAS	1	6	3.06	3.61
17	I only like very challenging operations	HAS	2	8	2.67	3.67
18	It is unacceptable when my operations are delayed	HAS	3	3	2.89	3.50
19	I often worry that I cannot finish the original surgical plan	HAS	3	2	2.67	3.11
20	If the medical condition of the patient is questionable, I find it disturbing to wait until anesthesia has fully optimized the patient	HAS	1	6	2.89	3.39
21	I often worry about complications, incidents and/or calamities when I operate	HAS	3	5	3.28	3.67
22	I'm basically an impatient surgeon	HAS	3	2	2.61	3.11
23	I like to perform high risk operations	HAS	4	2	2.67	3.61
24	I sometimes feel that I have little control over what happens to the patient	HAS	3	3	2.75	3.35
25	While performing surgery, I am always aware of the risk of needle stick incidents	HAS	6	3	2.78	3.56
26	The thoroughness of my preparation mostly determines the likelihood of me having problems during the case	HAS	0	6	3.22	3.22
27	The OR planning usually does not act as I want to	HAS	7	4	2.22	3.44

28	The rules and regulations of the scientific professional association are more of a hindrance than a help	HAS	1	5	2.72	3.67
29	A successful operation is totally dependent on a good preparation	HAS	0	5	3.17	3.17
30	I do not hesitate to perform unusual procedures	HAS	0	6	3.28	3.44
31	Reporting incidents or calamities is of minimal added value	HAS	1	7	3.11	3.78
32	If unexpected situations occur during the operation, I experience difficulties adapting the original surgical plan	HAS	0	4	2.89	3.44
33	A prospective risk inventory is mostly and merely a bureaucratic exercise	FG	1	4	3.06	3.50
34	Registering the completion of a “time out” and “sign out” procedure is essential	FG	1	4	3.33	3.72
35	I understand colleagues who do not follow the rules concerning door movements in the operating room	FG	2	1	2.50	3.56
36	Phoning someone during an operation has no influence on my performance	FG	2	2	2.83	3.67
37	My knowledge and skills are such, that I do not need any training on how to use new equipment	FG	0	6	2.89	3.61
38	The faster the operation, the better the surgeon	FG	5	4	2.39	3.67
39	I can operate for a long period (> hours), without taking a break	FG	1	3	2.94	3.83
40	If I have completed a busy night shift, I am able to operate the next morning	FG	0	8	3.22	3.50
41	Some existing rules I take for granted, as going against them does not help	FG	2	3	2.78	3.44
42	It is unacceptable to wear hand and/or wrist jewellery at work	FG	4	1	2.61	3.56
43	The clothes regulations “coat closed” and “forearms free” are both extremely annoying	FG	4	2	2.28	3.61

44	Since I am an expert in my field, patients are in best hands with me	FG	1	4	2.78	3.50
45	I perform above average in my professional group	FG	3	2	2.83	3.56
46	If the desired instruments are, after asking multiple times, not available yet, I just continue with the old material	FG	1	1	2.61	3.17
47	It is often unnecessary to involve other disciplines	FG	0	5	3.11	3.44
48	It is often more efficient to start on your own than to receive a handover from a colleague	FG	1	5	3.00	3.53
49	During my shift, I am reluctant to ask for advice from a colleague by telephone	FG	0	2	3.06	3.56
50	The hygiene rules in the hospital are totally right	FG	5	2	2.78	3.61
51	It is understandable for a doctor to be late in meetings or appointments	FG	4	2	2.33	3.28
52	I do not like to have my viewpoints discussed	GRAS	1	3	2.72	3.44
53	I do not welcome remarks about my personal functioning	GRAS	0	6	3.22	3.50
54	I am accountable for what I say	GRAS	0	3	3.28	3.56
55	I am open to discussion about my opinions	GRAS	1	5	3.39	3.44
56	I sometimes find myself having difficulty in illustrating an ethical standpoint	GRAS	4	2	2.61	3.06
57	I sometimes find myself having difficulties coming up with alternative solutions	GRAS	3	3	2.67	3.28

[1] Indicating where the item originates from, HAS (hazardous attitudes scale), FG (focus groups) or GRAS (Groningen Reflection Ability Scale). [2] Number of participants that labelled the item as one of the 10 items that deserved highest priority. [3] Number of participants that labelled the item as one of the 10 items that could be omitted from the list.
[4] Answer to: how relevant is this item to measure hazardous attitudes in medical practice?
[5] Answer to: how unambiguous is this item formulated?

** excluded based on a mean clarity ≤ 3.10 ** excluded based on a mean relevance ≤ 2.43. *** excluded based on both a mean relevance ≤ 2.43 and a mean clarity ≤ 3.10. **** excluded based on the prioritizing process of the participants*

Table 2. Characteristics of the participants in the testing phase of the SHARP instrument

Variable	N (%), N = 302
Setting	
University Medical Center	**89 (28,8)**
Tertiary Hospital	**180 (58.3)**
General hospital	**33 (10.7)**
Response rate	**302/558 (54.1)**
Gender	
Female attending physicians	**87(28.2)**
Male attending physicians	**215 (69.6)**
Age	
Mean attending physician's age	**47.2**
Mean years of experience attending physicians	**22.4**
Background participants	
number of cardiothoracic surgeons/total (% of subspecialty)	**15 (4.9)**
number of otorhinolaryngology/total (% of subspecialty)	**24(7.8)**
number of gynecologists/total (% of subspecialty)	**57 (18.4)**
number of plastic surgeons/total (% of subspecialty)	**23 (7.4)**
number of orthopedic surgeons/total (% of subspecialty)	**38 (12.3)**
number of general surgeons/total (% of subspecialty)	**93 (30.1)**
number of urologists/total (% of subspecialty)	**35 (11.3)**

Table 3. Mean, SD, Percentiles and Cronbach's Alpha of the six-scale structure of the SHARP questionnaire.

	Mean	SD	20th pct	80th pct	Cronbach's Alpha
1. Attitude towards Authority	3.63	0.40	3.40	4.00	0.778
2. Attitude towards self-performance	2.84	0.55	2.50	3.25	0.688
3. Attitude towards own fitness to perform	3.21	0.71	2.67	3.67	0.535
4. Attitude towards uncertainty	3.76	0.51	3.25	4.00	0.505
5. Attitude towards planned procedures	3.63	0.73	3.00	4.00	0.476
6. Attitude towards performance feedback	1.95	0.35	1.67	2.17	0.610

Table 4. Items, factor loadings, and item-to-scale correlations of the SHARP Instrument

Items SHARP**	Factor loadings	Item to scale correlations
1. Attitude towards authority		
1.1. I understand colleagues who do not follow the rules concerning door movements in the operating room	0.492	0.643
1.2. Reporting incidents or calamities is of minimal added value	0.454	0.490
1.3. The hygiene rules in the hospital are totally right	0.617	0.707
1.4. It is unacceptable to wear hand and/or wrist jewellery at work	*0.556*	*0.505*
1.5. The clothes regulations "coat closed" and "forearms free" are both extremely annoying	0.591	0.613
*1.6. Registering the completion of a "time out" and "sign out" procedure is essential **	*-0.483*	*0.657*
2. Attitude towards self-performance		
2.1. I only like to perform very challenging operations	0.793	0.811
2.2. I like to perform high risk operations	0.654	0.763
2.3. I perform above average in my professional group	0.502	0,666
2.4. Since I am an expert in my field, patients are in best hands with me	0.304	0.629
3. Attitude towards own fitness to perform		
3.1. If I have completed a night shift, I am able to operate the next morning	0.550	0.738
3.2. Phoning someone during an operation has no influence on my performance	0.499	0.681
3.3. I can operate for a long time ($\geq$ 4 hours) without taking a break	0.394	0.741
4. Attitude towards uncertainty		
4.1. While performing risky operations, I worry about not seeing landmarks and losing the overview.	0,414	0,645
4.2. I often worry that I cannot finish the original surgical plan	0.622	0.667

4.3. I often worry about complications, incidents and/or calamities when I operate	0.428	0.701
4.4. If an unexpected situation arises during the operation, I have a lot of difficulty adapting the original surgical plan	0.405	0.537
5. Attitude towards planned procedures		
5.1. The thoroughness of my preparation mostly determines the likelihood of me having problems during the case	0.419	0.788
5.2. A successful operation is totally dependent on a good preparation	0.613	0.834
Items GRAS		
6. Attitude towards feedback		
6.1. I do not like to have my viewpoints discussed	0,431	0,609
6.2. I do not welcome remarks about my individual performance	0,357	0,539
6.3. I am accountable for what I say	0,495	0,575
6.4. I am open to discussion about my opinions	0,551	0,575
6.5. I sometimes find myself having difficulty in illustrating an ethical standpoint	0,436	0,611
6.6. I sometimes find myself having difficulties coming up with alternative solutions	0,508	0,606

* This item can optionally be included in the SHARP list, however was excluded from the final list for statistical reasons. Including the item results in a Cronbach's Alpha of 0,59.

** In case the setting is not specified in the item itself, the item applies to all different work settings of surgeons (e.g. OR, while rounding, when seeing patients). In case the item applies to a specific setting, this is mentioned in the item explicitly.

Table 5. Inter-scale correlations of the SHARP instrument (Pearsons's correlation coefficients)

	Authority	Self-performance	Own fitness to perform	Uncertainty	Planned Procedures	Performance feedback
Authority	1					
Self-performance	0,050	1				
Own fitness to perform	0,055	0,317**	1			
Uncertainty	0,145*	-0,264**	-0,176**	1		
Planned Procedures	0,096	-0,183**	-0,005	-0,090	1	
Performance feedback	-0.314**	0,104	-0.070	-0,258**	-0,117*	1

* correlation is significant at the $p \leq 0,05$ level
** correlation is significant at the $p \leq 0,01$ level

Table 6. The six hazardous attitudes and their antidotes

ATTITUDE TOWARDS	HAZARDOUS ATTITUDE	ANTIDOTE
Self-performance The attitude towards surgeon's self-performance includes self-efficacy and assessment of own competencies. This in turn influences surgeons' decision-making process and risk assessment strategies.	"I can do anything"	"Taking chances is foolish"
Authority The attitude towards authority reflects whether surgeons acknowledge and act according to existing rules, regulations and agreements.	"Don't tell me what to do"	"Follow and respect the rules. They are usually right and exist for a reason"

Own fitness to perform This attitude includes surgeons' adequate perception of their own abilities and their fitness to perform. This results in a sense of vulnerability on the one hand and complete invulnerability on the other hand.	"It won't happen to me"	"I am a human-being, it could happen to me"
Uncertainty This attitude reflects surgeons' ability to deal with uncertainty and their capability to adapt to unexpected situations arising during procedures.	"Not having control, is making me nervous"	"I am capable to adapt to a new situation"
Planned procedures This attitude reflects to which extent surgeons rely on the preparation of their procedures and how this affects their confidence level.	"Without preparation, I am nowhere"	"Not being totally prepared does not affect my confidence level"
Performance feedback This attitude reflects surgeons' openness to provide and receive feedback.	"Who are you to tell me this? I am an excellent surgeon."	"How can we help each other grow?"