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SYMPOSIUM: PATIENT SAFETY: COLLABORATION, COMMUNICATION, AND PHYSICIAN LEADERSHIP

How Prevalent Are Hazardous Attitudes Among Orthopaedic Surgeons?

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Abstract

Background So-called "hazardous attitudes" (macho, impulsive, antiauthority, resignation, invulnerable, and confident) were identified by the Federal Aviation Administration and the Canadian Air Transport Administration as contributing to road traffic incidents among college-aged drivers and felt to be useful for the prevention of aviation accidents. The concept of hazardous attitudes may also be useful in understanding adverse events in surgery, but it has not been widely studied.

Questions/purposes We surveyed a cohort of orthopaedic surgeons to determine the following: (1) What is the prevalence of hazardous attitudes in a large cohort of orthopaedic surgeons? (2) Do practice setting and/or demographics influence variation in hazardous attitudes in our cohort of surgeons? (3) Do surgeons feel they work in a climate that promotes patient safety?

Methods We asked the members of the Science of Variation Group—fully trained, practicing orthopaedic and trauma surgeons from around the world—to complete a questionnaire validated in college-aged drivers measuring six attitudes associated with a greater likelihood of collision and used by pilots to assess and teach aviation safety. We accepted this validation as applicable to surgeons and modified the questionnaire accordingly. We also asked them to complete the Modified Safety Climate Questionnaire, a questionnaire assessing the absence of a safety climate that is based on the patient safety cultures in healthcare organizations instrument. Three hundred sixty-four orthopaedic surgeons participated, representing a 47% response rate of those with correct email addresses who were invited.

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Each author certifies that his or her institution approved the human protocol for this investigation, that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained.
This work was performed at the Orthopaedic Hand and Upper Extremity Service, Massachusetts General Hospital, Boston, MA, USA.

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Results Thirty-eight percent (137 of 364 surgeons) had at least one score that would have been considered dangerously high in pilots (> 20), including 102 with dangerous levels of macho (28%) and 41 with dangerous levels of self-confidence (11%). After accounting for possible confounding variables, the variables most closely associated with a macho attitude deemed hazardous in pilots were supervision of surgical trainees in the operating room ($p = 0.003$); location of practice in Canada ($p = 0.059$), Europe ($p = 0.021$), and the United States ($p = 0.005$); and being an orthopaedic trauma surgeon ($p = 0.046$) (when compared with general orthopaedic surgeons), but accounted for only 5.3% of the variance ($p < 0.001$). On average, 19% of surgeon responses to the Modified Safety Climate Questionnaire implied absence of a safety climate. *Conclusions* Hazardous attitudes are common among orthopaedic surgeons and relate in small part to demographics and practice setting. Future studies should further validate the measure of hazardous attitudes among surgeons and determine if they are associated with preventable adverse events. We agree with aviation safety experts that awareness of amelioration of such attitudes might improve safety in all complex, high-risk endeavors, including surgery—a line of thinking that merits additional research.

Introduction

The medical field has prioritized quality and safety and seeks to recreate the achievements of aviation and manufacturing [2, 17]. In 1984, the Federal Aviation Administration (FAA) and the Canadian Air Transport Administration identified five hazardous attitudes that were thought to adversely influence judgment: macho, impulsive, antiauthority, resignation, and invulnerable [1, 3, 4]. Given the low rate of aviation accidents, they validated a modified questionnaire in college-aged drivers, an analogous population with high accident rates and identified a sixth attitude, adding "confident" [8]. Training about hazardous attitudes is now standard for all pilots [5, 18].

The observation that general aviation accidents are more common in pilots with an advanced degree suggest that attitude may be more important than intelligence [24]. Intuitively, personality factors that might correlate with hazardous attitudes – including independence, self-sufficiency, and assertiveness – might be more predominant among more accomplished individuals [14].

We agree with aviation experts that a questionnaire modified in college aged drivers is likely applicable to surgeons. Adverse events that are distinctly due to surgeon error are uncommon and often difficult to distinguish from illness severity or bad luck. In a prior study using a questionnaire modified for surgeons we did find a small correlation between some hazardous attitudes and unplanned readmission or return to the operating room [13]. While additional validation is merited, it seems plausible that hazardous attitudes are a factor in medical error and surgical adverse events and warrant greater attention.

In this study we used a large, web-based collaborative of practicing orthopaedic surgeons to address the following study questions: (1) What is the prevalence of hazardous attitudes in a large cohort of orthopaedic surgeons? (2) Do practice setting and/or demographics influence variation in hazardous attitudes in our cohort of surgeons? (3) Do surgeons feel they work in a climate that promotes patient safety?

Materials and Methods

Participants

In this cross-sectional study, we asked members of the Science of Variation Group (SOVG), a large cohort of orthopaedic surgeons, to complete an online survey through an invitation sent to their email address. A total of 805 surgeons were invited by email, but 32 emails were inaccurate. Among the remaining 773 surgeons, 365 never responded, 24 opted out, and 20 had only completed part of the survey at the time of survey closure, leaving 364 surgeons (47% of the 773 surgeons with a working email; 89% of responders) who completed the survey.

Description of Study Procedures

The institutional review board at the principal investigator's hospital approved this study. After surgeons accepted the invitation, standard demographic data were collected, including sex, age, years in practice, region of practice, type of orthopaedic subspecialty, and whether the surgeons supervised trainees in the operating room. Also, we asked them to complete the Modified Surgeon Hazardous Attitude Scale and the Modified Safety Climate Questionnaire.

Variables, Outcome Measures, Data Sources, and Bias

The Hazardous Attitude Scale is a 30-question survey created by Dr David R. Hunter, the retired lead scientist for Human Performance at the Office of Aerospace Medicine, FAA, Washington, DC, USA, building on the initial parallel population work by Dr Holt [7, 10]. The scale measures six hazardous attitudes: macho, impulsive, antiauthority, resignation/external locus of control, self-confidence, and worry/anxiety. It is freely available online (http://www.avhf.com/html/evaluation/GMasonHazAttitudeScale/GM2.asp) and

the scoring is done by summing the five Likert-type responses separately for each attitude with 1 being "strongly disagree" and 5 being "strongly agree" [10]. In aviation, scores are interpreted as follows: an average score is approximately 15. Higher scores indicate a tendency toward that particular attitude and if one of the scores is > 20, special precautions should be taken to ensure flight safety [10]. We used the same scales and thresholds to evaluate surgeons with the statements converted to surgical scenarios; for example, the word pilot was substituted for surgeon and FAA for OR scheduling. Examples of converted questions are: "I am a pilot due entirely to my hard work and ability" (Appendix 1 [Supplemental materials are available with the online version of CORR®.]) to "I am a surgeon due entirely to my hard work and ability" (Appendix 2); or alternatively, "The FAA is more of a hindrance than a help' (Appendix 1) to "The OR scheduling desk is more of a hindrance than a help" (Appendix 2). The definitions for hazardous Attitudes (score > 20) are derived from previous work in pilots, suggested by Dr Hunter [11].

The Modified Safety Climate Questionnaire is based on the Patient Safety Climate in Healthcare Organizations instrument [21]. It focuses on five domains: organization, department, production, reporting/seeking help, and shame/self-awareness. It is also rated on 5-point Likert scales. Outcomes were reported as rates of problematic responses (4 or 5 on the Likert scale) for each item, which implied the absence of a safety climate. This questionnaire has not been internally validated but has been used previously at the principal investigator's (DR) hospital to describe the safety climate among residents [14].

Statistical Analysis

There was no difference in the total score on the self-confidence hazardous attitude scale among surgeons of different subspecialties. We performed a post hoc power analysis using the data generated from analysis of the self-confidence scores to determine the power necessary to detect this observed effect. The power to detect a variance of means of 0.15 with a common SD of 2.8 in a group of 364 with a significance level of 0.01 is 32%. To achieve a power of 80% based on the means and spread in our study, a total sample size of 829 is necessary.

The Modified Surgeon Hazardous Attitude Scale scores were transformed into dichotomous variables by using the normal cutoff of 20 points. Scores for any of the six attitudes above 20 points were considered hazardous. The relationships between the dichotomous hazardous attitude variables and categorical variables were assessed with Pearson's chi-square tests, and the relationships with continuous variables were evaluated with independent t-tests. Variables with $p < 0.10$ were entered into a backward multivariable logistic regression analysis looking for independent predictors of "hazardous attitudes." Categorical variables with more than two categories were entered into the multivariable analyses as dummy-coded variables.

In bivariable analysis, we looked for associations between "hazardous attitudes" and independent variables including sex, age, years in practice, region of practice, type of orthopaedic subspecialty, and whether the surgeons supervised trainees in the operating room. The relationships between the Modified Surgeon Hazardous Attitude Scale scores and dichotomous variables were assessed with Pearson's chi square tests. The correlations between scale scores and categorical variables with more than two categories were determined with one-way analysis of variance. Variables with $p < 0.10$ were entered in a backward multivariable linear regression model looking for independent predictors of the Modified Surgeon Hazardous Attitude Scale scores. Categorical variables with more than two categories were entered into the multivariable analyses as dummy-coded variables.

Demographics

Of the 364 surgeons who completed the online survey, 336 (92%) were men. Most observers were either from Europe (24%) or the United States (54%). The majority of participating surgeons specialized in orthopaedic traumatology (33%) or hand and wrist surgery (39%). The number of years in independent practice was well distributed within the group (Table 1).

Results

Proportion of Surgeons With Potentially Hazardous Attitudes

Thirty-eight percent of surgeons (137 of 364 surgeons) displayed at least one dangerously high level of a hazardous attitude on The Modified Surgeon Hazardous Attitude Scale according to the interpretation previously suggested to pilots by Dr Hunter: 102 macho (28%), 41 self-confidence (11%), 22 worry/anxiety (6%), 10 antiauthority (3%), four impulsivity (1%), and a single surgeon resignation/external locus of control (0.27%) (Table 2).

Association of Practice Settings With Potentially Hazardous Attitudes

After accounting for possible confounding variables, the variables most closely associated with a dangerous level of

Table 1. Observer demographics (n = 364)

Demographic	Number	Percent
Sex		
Male	336	92.3
Female	28	7.7
Region of practice		
Asia	15	4.1
Australia	8	2.2
Canada	17	4.7
Europe	88	24.2
United Kingdom	14	3.8
United States	195	53.6
Other	27	7.4
Subspecialty		
General orthopaedic surgery	19	5.2
Orthopaedic trauma surgery	121	33.2
Shoulder and elbow surgery	64	17.6
Hand and wrist surgery	140	38.5
Other	20	5.5
Years in independent practice		
0–5	112	30.8
6–10	77	21.2
11–20	112	30.8
21–30	63	17.3
Supervision of surgical trainees in operating room		
Yes	312	85.7
No	52	14.3

Table 2. Modified surgeon hazardous attitude scale (n = 364)

Subscale	Number of observers who scored > 20 points*	Percent
Self-confidence	41	11
Worry/anxiety	22	6
Macho	102	28
Impulsive	4	1
Antiauthority	10	3
Resignation/external locus of control	1	0

* Greater than 20 points indicates a dangerously high level of specific hazardous attitude.

Table 3. Multivariable analysis—dangerously high level of any hazardous attitude (n = 364)

Any hazardous attitude	p value	Odds ratio	95% CI for odds ratio	
			Lower	Upper
Supervision of surgical trainees in OR	0.027	2.2	1.1	4.4
Practice in Asia	0.020	3.7	1.2	11.2
Practice in Canada	0.074	2.5	0.9	6.7

Nagelkerke $R^2 = 0.053$; Hosmer and Lemeshow test = 0.602; CI = confidence interval; OR = operating room.

any hazardous attitude were supervision of trainees in the operating room (odds ratio [OR] = 2.2, p = 0.027), practice in Asia (OR = 3.7, p = 0.020), and practice in Canada (OR = 2.5, p = 0.074), but accounted for only 5.3% of the variation (Appendix 3 [Supplemental materials are available with the online version of CORR®.]; Table 3).

After accounting for possible confounding variables, the variables most closely associated with a level of self-confidence deemed hazardous in pilots were supervision of trainees in the operating room (OR = 3.5, p = 0.10) and practice in Asia (OR = 7.6, p < 0.001), in Canada (OR = 3.2, p = 0.056), and in "another" region (South America and Russia; OR = 3.1, p = 0.026) when compared with surgeons in the United States, but accounted for only 10% of the variation (Appendix 4 [Supplemental materials are available with the online version of CORR®.]).

After accounting for confounding variables, the variable most closely associated with a higher macho score included supervision of trainees in the operating room (p = 0.0027); surgeons practicing in Canada (p = 0.0587), Europe (p = 0.021), and in the United States (p = 0.0047) (when compared with "another" region); and being an orthopaedic trauma surgeon (p = 0.046) (when compared with general orthopaedic surgeons), but explained only 5.3% of the variability (p < 0.001; Appendix 5; Table 4).

After accounting for confounding variables, the variable most closely associated with higher levels of worry included not being in independent practice for 11 to 20 years (p = 0.0015), location of practice in Asia (p < 0.001), and in "another region" (p < 0.001) (when compared with surgeons practicing in the United States) and accounted for 14% of the variability (p < 0.001; Appendix 4; Table 4).

After accounting for confounding variables, the variable most closely associated with higher levels of resignation included surgeons practicing in Asia (p < 0.001), Europe (p = 0.045), and in "another region" (p < 0.001) (when compared with surgeons practicing in the United States) and being in independent practice for 0 to 5 years (p = 0.0076) and 6 to 10 years (p = 0.0024) (when compared with being in independent practice for 21–30 years), but accounted for only 12% of the variation (p < 0.001; Appendix 4; Table 4).

Patient Safety Climate

On average, 19% of surgeon responses to the Modified Safety Climate Questionnaire implied concerns about the climate of safety. Rates of responses implying a poor safety

Table 4. Multivariable analysis—attitude scale scores (n = 364)

Specific multivariable model	Adjusted R^2	p value
Best model higher worry scale score		
Practicing in Asia and other region (compared with United States)	0.14	< 0.001
Not being for 11–20 years in independent practice (compared with 0–5 years)		
Best model higher macho scale score		
Supervision of surgical trainees in operating room	0.053	< 0.001
Practicing in Canada, Europe, and United States (compared with other region)		
Orthopaedic trauma surgeons (compared with general orthopaedic surgeons)		
Best model higher resignation scale score		
Practicing in Asia, Europe, and other region (compared with United States)	0.12	< 0.001
0–5 years in independent practice and 6–10 years in independent practice (compared with 21–30 years)		

Table 5. Safety climate: top 10 items with the highest problematic response rates (n = 365)

	Items	Proportion of problematic responses*
1	Senior management does not hesitate to temporarily restrict clinicians who are under high personal stress	0.52
2	Senior management reacts well to unexpected changes to its plan	0.51
3	Loss of experienced personnel has negatively affected my ability to provide high-quality patient care	0.54
4	My program follows a specific process to review performance against defined training goals	0.24
5	Patient safety decisions are made at the proper levels by the most qualified people	0.23
6	My program closely monitors performance to ensure clinicians are qualified	0.23
7	Senior management has a clear picture of the risks associated with patient care	0.22
8	In my department, there is significant peer pressure to discourage unsafe patient care	0.20
9	Good communication flow exists down the chain of command regarding patient safety issues	0.20
10	I am provided adequate resources (personnel, budget, and equipment) to provide safe patient care	0.19

climate ranged from 0% to 52% on individual questions among this group of surgeons (Table 5).

Discussion

To err is human, but—as the experience of aviation and manufacturing has established—a culture of safety including systems that account for our shortcomings can help prevent human errors from causing harm [16]. Given that hazardous attitudes correlate with motor vehicle collisions in college-aged drivers and that aviation safety experts believe that awareness and amelioration of hazardous attitudes can prevent aviation accidents, we believe the concept of hazardous attitudes can also be applied to the prevention of surgical errors. One step is to assess the prevalence of hazardous attitudes among surgeons and determine if specific factors are associated with hazardous attitudes. We also assessed surgeons' impressions of their safety climate.

This study should be interpreted in light of the fact that the majority of the surgeons were from either the United States or Europe and supervised trainees in the operating room, suggesting they were primarily from teaching hospitals. Also, as noted in the study by Gaba et al. [6], the wording of the questions between the domains of aviation and health care cannot be perfectly matched, because they are context-dependent. Furthermore, there is a minimal association of hazardous attitudes with adverse surgical outcomes to date [13]. On the other hand, just as aviation safety experts feel that the substantial similarities of college-aged drivers and pilots far outweigh the differences, it seems plausible to assume that a valid measure of hazardous attitudes in drivers is likely to be useful among surgeons as well. Just as the number of aviation accidents is too low to study the influence of hazardous attitudes, the low number of certain errors by the surgeon will also limit scientific investigation here.

There are also several limitations related to the SOVG and its methodology. English is not the primary language

of a substantial percentage of participants, but all of them are English-proficient. There is always a large number of nonresponders in the Science of Variation Group surveys, primarily because we have not culled out emails of people who are less likely to participate. This was one of our first "all surgeon" surveys (eg, not focused on a specialty) and many new surgeons were invited. There is selection bias in the participants of this survey, but more so as a result of the selective makeup of the SOVG than the response rate per se. None of the SOVG surveys can be considered representative of the average orthopaedic surgeon, but they do give a window into the specialty and allow us to look for differences in sociodemographic and practice variations. We cannot compare responders and nonresponders because so many of the nonresponders had never enrolled in an SOVG study, so we do not have their demographic and practice information.

Another point of discussion is the use of $p < 0.10$ as a criterion for inclusion in the multivariable model. The reader should understand that this does not indicate that we accepted a higher rate of false-positive findings. Rather, the multivariable analysis was the definitive analysis (where a $p < 0.05$ was necessary for the entire model) and the $p < 0.10$ criterion was used merely to limit the number of variables entered in to the model given the limited number of survey participants. Finally, the reader should keep in mind that each study can only ask one question well and all of our secondary questions beyond the rate of hazardous attitudes among SOVG surgeons should be considered provisional and hypothesis-generating at best. As an additional caution, some of the comparisons based on demographic and practice differences are underpowered, which is frequently the case in the analysis of secondary study questions and analysis of subgroups.

We found that more than one-third of surgeons have a dangerously high level of at least one hazardous attitude (most commonly "macho"). In 2001, Holt redesigned a hazardous attitudes scale published by the FAA without validation [4]; he changed the ipsative scale (a scale in which the test subject chooses between options) into Likert-type responses (in which the test subject chooses a score, for example between 1 and 5) and validated it using a version altered to apply to automobile driving and tested it on college-aged drivers (238 undergraduate students). Factor analyses demonstrated groupings of questions comparable to those in the FAA instrument (macho, impulsivity, antiauthority, and resignation) as well as a new grouping: confidence or competence in driving. Holt found that resignation was correlated with decreased seatbelt use and negative reactions from passengers. Impulsive and antiauthority were significantly correlated with accidents, drinking while driving, moving violations, decreased seatbelt use, and increased insurance rates. Invulnerable was correlated with more parking tickets, reduced seatbelt use, and negative reactions from other drivers. Confident was correlated with drinking and driving as well as with less accidents and positive feedback from passengers [23]. To assess the prevalence of hazardous attitudes in pilots, Hunter developed a 27-item questionnaire and set up a nationwide survey of 19,657 pilots [9]. He found that only the items assessing pilot opinion of how careful and cautious they were associated with accident involvement. Hunter subsequently decreased the number of questions using only the most heavily weighted questions per attitude [12].

Pilots are now trained to recognize and counteract hazardous attitudes. The presence of these hazardous attitudes among surgeons (and perhaps more so among some subsets of surgeons) is no surprise [13]. If the correlation between hazardous attitudes and adverse events of surgery can be more definitively demonstrated, it would compel us to follow the lead of aviation safety in promoting awareness and amelioration of these attitudes. On the other hand, delaying attention to this matter on the grounds of imperfect science might be unwise. Many of us find the analogy with college-aged drivers as compelling as the pilots did and will attend to this with the current state of evidence while additional studies are underway.

The responses of one-fifth of surgeons in our study indicated a problematic safety climate.

This is consistent with a previous study of high-risk hospital personnel (nurses/physicians in the operating room, emergency department, intensive care unit, pediatric intensive care unit) that reported an average of 20.4% problematic responses compared with 5.6% among naval aviators [6].

This represents a substantial opportunity to improve how we prepare for and neutralize human error. The evidence that safety climate correlates with improved patient safety and healthcare outcomes [15, 19, 20, 22] is compelling, but culture change requires more than data.

In aviation and manufacturing—where technology has markedly improved quality and safety—there is a strong focus on human factors that contribute to medical error. Given the prevalence of hazardous attitude and problematic safety culture identified in this survey, we support the development of systems that help surgeons: (1) remain aware that to err is human; (2) expect that—as high achievers and inherent risk takers—they are prone to hazardous attitudes; and (3) recognize and counteract attitudes that might negatively impact patient care. Future studies might try to confirm that hazardous attitudes lead to surgical error, determine whether attention to hazardous attitudes can reduce errors and improve the safety culture, and address whether certain subspecialties, cultures, or training levels are more prone to hazardous attitudes.

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