Errors and the Burden of Errors: Attitudes, Perceptions, and the Culture of Safety in Pediatric Cardiac Surgical Teams

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Background. **The fear of committing clinical errors in perioperative care has a negative impact on the psychological well-being of surgical team members and ultimately on patient care. We assessed the perceptions and attitudes of surgical teams relative to committing errors, the impact of errors, and the culture of safety.**

Methods. **Pediatric cardiac surgery team members at three academic hospitals were surveyed. The survey included scaled, open-ended questions and a clinical vignette. Respondents were asked about the safety climate, team climate, stress recognition, and the impact of error as they relate to making and the anticipation of making clinical errors.**

Results. **The response rate was 69%. Safety attitudes were influenced by the work environment climate. Many respondents felt unable to express disagreement and had difficulty raising safety concerns. Staffing levels, equipment availability, production pressures, and hectic schedules were concerns. Respondents admitted that errors occurred repeatedly, and that guidelines and policies were often disregarded.**

Conclusions. **A psychometrically sound teamwork culture tool was used and demonstrated that surgical teams are influenced by the recognition of medical errors and that these errors carry significant personal burden. The findings suggest that the safety attitudes among team members may impact their performance and need to be carefully taken into consideration. Providers' reluctance to share safety events with others, as well as the perceived powerlessness to prevent events, must be addressed as part of an overall strategy to improve patient care outcomes. The study points to the need to address teamwork culture in efforts to improve patient care.**

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Patient safety is enhanced through team training and supportive management [1–5], and by infusing clinical microsystems with redundant core safety elements [6]. An institution's ability to create safe patient outcomes can be improved when it engenders a culture of safety among its staff [1]. The biggest challenge in moving toward a safer health system is often cultural. A culture of blame, in which errors are seen as personal failures, should ideally be replaced by a culture in which errors are seen as opportunities to improve the system [7].

Culture can be defined as the collection of individual and group values, attitudes, and practices that guide the behavior of group members [8–11]. Characteristics of a strong safety culture include a commitment to discuss and learn from errors, recognition of the inevitability of errors, proactive identification of latent threats, and incorporating nonpunitive systems for reporting and analyzing adverse events [11, 12]. Studies of safety culture have focused mainly on discovering deficits in organization, communications, or personal skills [1–5]. Previous studies have also highlighted the relationship between safety attitudes and team performance [2–4]. However, they have not explored the beliefs, attitudes, and behaviors of team members with respect to patient safety, nor have they studied the psychological and

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physical impact of the risk of error and its burden on individual team members' perceptions and performance. These issues are especially prominent in pediatric cardiac surgery (PCS), in which outcomes of high-risk patients depend on sophisticated team coordination and a high level of cognitive and technical performance [13–16].

As part of an effort to better understand how these factors influence the performance of individuals and their teams, the aim of this study was to explore the impact of real and potential medical errors on PCS team members.

Material and Methods

Design and Study Population

Pediatric cardiac surgery teams from three urban academic health centers agreed to participate in this study. Institutional review board approval was obtained from each institution, and written informed consent was obtained from participating PCS members. Pediatric cardiac surgery members were surveyed in 2004 and 2005 and were given paper copies of the questionnaire or provided with an online survey option. Surveys were introduced at PCS team meetings. A local champion assisted at each site. The Web-based and paper form data were deidentified, and information was entered into a computerized database (Microsoft Access, Microsoft Corp, Redmond, WA).

Questionnaire

Because survey results based on preformulated questions might lead respondents in particular directions, we chose a more complex methodology to increase study validity. Scaled questions were taken from validated studies to explore areas of known importance described in the safety culture literature. In addition, new areas were described, and scaled questions were formulated based on the clinical experience of our research team members. A clinical scenario and a set of open-ended questions were added to the scaled questions to increase the validity and interpretability of the study. A detailed description of the methods is given below.

Scaled Questions

The questionnaire included 30 questions adapted from the validated Safety Attitudes Questionnaire, operating room version [17]. We further formulated 28 new items that pertained to PCS teams, not available on the Safety Attitudes Questionnaire, based on roundtable discussions, reviewing the literature, our clinical experience, and a previously partially validated study [18]. The complete questionnaire included two separate domains for categorizing the respondent's perceptions. The first domain, Safety Attitudes, represents caregiver attitudes on the scales of teamwork climate, safety climate, and stress recognition. These factors were described in an investigation of the psychometric properties of Safety Attitudes Questionnaire [17]. The second domain, Impact of Error, relates to the organizational and personal burdens that are direct consequences of making clinical errors.

Respondents indicated the extent to which they agreed with each statement on a 4-point Likert-type scale consisting of "disagree strongly," "disagree slightly," "agree slightly," or "agree strongly." Respondents were expected to formulate agreement or disagreement with no neutral answer. Respondents were allowed, however, to select "don't know" as a possible answer.

Clinical Vignette of Adverse Event

The clinical scenario was developed to probe the attitudes of study participants about adverse event reporting, which is an important dimension of safety culture. The clinical scenario was based on an adverse event that involved a tenfold overdose of heparin that caused excessive bleeding after a cardiopulmonary bypass procedure. The scenario was designed to provide an external correlate to the scales derived from the attitude questionnaire.

Open-Ended Questions

Four open-ended questions were created to invite participants to give an uncued response that could be correlated with the responses of the scaled questions. Respondents were asked to list errors that they had observed and whether these errors were personal learning opportunities that they would like to share with their colleagues. They were asked whether job concerns affected their sleep. Finally, respondents were asked to give recommendations for improving patient safety. Two of the researchers (A.B., D.B.) coded the open-ended questions using content analysis into themes that were developed inductively based on existing literature. Each researcher independently decided on a content category, and then categorizations were compared. Discrepancies in coding were reconciled through consensus to determine the final classification.

Statistical Analysis

All analyses were carried out using the SAS statistical package (SAS/STAT Version 6, 4th edition, volume 1, 1989; SAS Institute, Inc, Cary, NC). There was consensus among the researchers that "don't know" responses could not be regarded as neutral, as opinions were being probed. Consequently, "don't know" responses were recoded as missing values. Percentages and mean values are based on nonmissing responses. For all factor analyses the pairwise covariance matrix was used for input.

Items in each domain were submitted for an exploratory factor analysis. A confirmatory factor analysis was performed on each domain to measure the adequacy of the final factor structure [19]. An exploratory factor analysis was done with the 29 items proposed for the Safety Attitudes domain. The items were preselected into the three proposed factors and predicated on the factor structure outlined for the psychometric properties of the Safety Attitudes Questionnaire [17]. After eliminating items with either low factor loadings or substantial "cross-factor" loadings, or both, a final factor structure was produced.

The scalability of the factor structure was evaluated, and the discriminant validity of the scales was evaluated

Table 1. Factor Analysis of the Safety Attitudes Domain[a]

Factor	N	% Agreed	Mean ± SEM	Factor Loading
Factor 1. Team Climate (Cronbach's α = 0.89)				
In our OR it is difficult to speak up if I perceive a problem with patient care	55	29	2.96 ± 0.14	−0.86
Surgeon and anesthetist maintain open channels of communication throughout the procedure	58	86	1.70 ± 0.11	0.79
Surgeon and perfusionist maintain open channels of communication throughout the procedure	59	93	1.39 ± 0.09	0.78
Nurse input about patient care is well received in the OR	54	65	2.22 ± 0.12	0.74
It is easy for our OR staff to ask questions when there is something that they don't understand	56	75	2.20 ± 0.12	0.73
Morale in our OR is high	55	45	2.60 ± 0.13	0.72
Disagreements in the OR are appropriately resolved (ie, what is best for the patient)	52	73	2.10 ± 0.12	0.64
Senior staff encourage questions from junior medical and nonmedical staff during operations	52	65	2.27 ± 0.13	0.67
I am frequently unable to express disagreement with the attendings in our OR	56	41	2.75 ± 0.13	−0.60
OR staff are briefed before surgical procedures	50	44	2.56 ± 0.13	0.54
Factor 2. Safety Climate (Cronbach's α = 0.75)				
Debriefing after errors occur is common	48	29	2.92 ± 0.14	0.68
My patient safety is not reduced when I am interrupted	60	33	2.75 ± 0.09	0.67
The culture in our OR makes it easy to learn from mistakes of others	51	43	2.68 ± 0.13	0.65
My decision making is as good in medical emergencies as in routine situations	60	78	1.88 ± 0.10	0.64
I receive appropriate feedback about my performance	55	62	2.20 ± 0.13	0.49
Nurses should not question decisions made by attendings	61	5	3.52 ± 0.08	0.49
The attending surgeon should be formally in charge of the OR during the surgical procedure	57	63	2.07 ± 0.16	0.47
Effective coordination of OR staff requires that the personalities of others be taken into account	56	82	1.86 ± 0.11	−0.43
It is difficult to discuss mistakes when they occur in the OR	52	60	2.42 ± 0.14	−0.41
Factor 3. Stress Recognition (Cronbach's α = 0.72)				
Fatigue impairs my performance during critical phases of patient care	60	73	2.16 ± 0.11	0.84
Stress from personal problems adversely affects my performance	61	46	2.77 ± 0.12	0.79
When my workload becomes excessive, my performance is impaired	55	75	2.04 ± 0.12	0.71
High levels of workload are common in our OR	53	94	1.60 ± 0.09	0.40

[a] Number of responses, percent agreed, item mean ± standard error of the mean, and factor loadings.

OR = operating room; SEM = standard error of the mean.

by computing the correlation of each retained item with all scales within its domain [19]. The scales within each domain were correlated with responses to the patient case scenario to assess external validity. Scale scores for each domain were compared among specialties by analysis of variance. Finally, multiple regression analyses of the scale scores were performed using the independent variables age, sex, years in specialty, years at the current

Table 2. Safety Attitude Domain Scales by Specialty[a]

Specialty	Teamwork Climate	Safety Climate	Stress Recognition
Anesthesia (n =24)	3.0 ± 0.13	2.2 ± 0.11	2.9 ± 0.14
Nurses and technicians (n =15)	2.8 ± 0.12	2.5 ± 0.11	2.8 ± 0.16
Perfusion (n =10)	2.3 ± 0.22	2.5 ± 0.19	3.1 ± 0.18
Surgery (n =7)	3.1 ± 0.19	2.5 ± 0.17	2.9 ± 0.23

[a] Values reported as mean ± standard error of the mean.

Table 3. Factor Analysis of the Error Burden Domain[a]

Factor	N	% Agreed	Mean ± SEM	Factor Loading
Factor 1. Error Management (Cronbach's $\alpha = 0.82$)				
My department provides adequate, timely information about events in the hospital that might affect my work	59	68	2.10 ± 0.14	0.82
I am encouraged by my colleagues to report any patient safety concerns	59	78	1.94 ± 0.13	0.74
I know the proper channels to direct questions regarding patient safety in my department or work area	57	95	1.51 ± 0.09	0.67
Our levels of staffing are sufficient to handle the number of patients	52	31	2.79 ± 0.12	0.55
Trainees in my discipline (eg, nurses, residents) are adequately supervised	53	79	1.83 ± 0.11	0.53
I have used the hospital's reporting system for documenting medical errors	51	61	2.23 ± 0.19	0.52
Decision making in our OR should include more input from other OR staff than it does now	50	74	1.96 ± 0.11	−0.51
Disruptions in continuity of patient care can be detrimental to patient safety	58	93	1.48 ± 0.08	−0.48
Problems with equipment are frequent in the OR	52	69	2.17 ± 0.14	−0.46
We have a confidential reporting system for documenting medical errors	47	85	1.65 ± 0.13	0.42
When medical errors occur they are handled appropriately	53	85	1.77 ± 0.11	0.42
Factor 2. Risk Modification (Cronbach's $\alpha = 0.84$)				
I am properly trained to use new and existing equipment in the OR	55	89	1.71 ± 0.11	0.77
Errors because of lack of skill are rare in the OR	52	58	2.23 ± 0.13	0.75
The OR equipment in our hospital is adequate	53	47	2.58 ± 0.15	0.72
Errors because of lack of knowledge are rare in the OR	54	59	2.24 ± 0.13	0.70
I would feel perfectly safe as a patient in our OR	59	64	2.08 ± 0.14	0.66
I am afraid to report adverse events as I might be punished or lose my job	60	12	3.57 ± 0.10	−0.53
I am reluctant to report adverse events as I might get a colleague or friend in trouble	60	15	3.45 ± 0.09	−0.52
I expect to be consulted on matters that affect the performance of my duties	55	95	1.29 ± 0.08	0.40
Factor 3. Error Burden (Cronbach's $\alpha = 0.75$)				
I have seen others make errors that had the potential to harm patients	58	91	1.59 ± 0.10	0.77
I am more likely to err in a tenser hostile situation	60	85	1.75 ± 0.11	0.72
I have made mistakes that had the potential to harm patients	59	83	1.88 ± 0.11	0.58
I am ashamed when I make a mistake in front of other OR staff	55	75	2.07 ± 0.13	0.56
I have seen the same mistakes occur again and again	54	33	2.90 ± 0.15	0.55
Medical errors occur every day in our OR	49	41	2.75 ± 0.15	0.45
There are frequent changes to the schedules	54	91	1.52 ± 0.09	0.45
Errors committed during patient management are not important, as long as the patient improves	59	3	3.78 ± 0.07	−0.43
OR personnel often disregard rules or guidelines	56	39	2.89 ± 0.14	0.41

[a] Number of responses, percent agreed, item mean ± standard error of the mean, and factor loadings.

OR = operating room; SEM = standard error of the mean.

hospital, and loss of sleep as a result of provider concerns. Responses to individual scale items are presented as the number of subjects responding (mean ± standard error of the mean) and percent of respondents agreeing or disagreeing with the item.

Results

Respondent Demographic

Sixty-one of 89 potential PCS team respondents completed the questionnaire (69% response rate). Data from the three institutions were combined into one database to assure anonymity. The sample consisted of 24 anesthesiologists, 15 nurses or technicians (scrub, circulating, and one physician assistant), 10 perfusionists, 7 surgeons, and 5 respondents who did not indicate their profession. This distribution of respondents is representative of the structure of most PCS teams, and of the teams at the three participating institutions. Fifty-one percent of the respondents were female; 46% male; the sex of 2 respondents was not indicated. The average age of respondents was 41 years (standard

Table 4. Impact of Error Domain Scales by Specialty (Means ± Standard Error of the Mean)

Specialty	Error Management	Risk Perception	Error Burden
Anesthesia (n =24)	2.7 ± 0.10	3.0 ± 0.13	3.1 ± 0.08
Nurses and technicians (n =15)	2.8 ± 0.07	3.2 ± 0.16	2.5 ± 0.15
Perfusion (n =10)	2.4 ± 0.22	3.1 ± 0.18	3.1 ± 0.11
Surgery (n =7)	2.8 ± 0.23	3.2 ± 0.21	3.0 ± 0.17

deviation = 8.5; range, 26–60); the average time in the specialty field was 12.4 years (standard deviation = 9.07; range, 0.5–40); and the average time in their role at the current hospital was 10.1 years (standard deviation = 9.19; range, 0.5–40).

Safety Attitudes Domain Scale Psychometrics

The items, descriptive statistics, Cronbach's α, and factor loadings for each factor are shown in Table 1. The items in the Safety Attitudes domain derived from the Safety Attitudes Questionnaire showed up in their proper factor, supporting the validity of the factor structure and the responses in this study [17]. These findings indicate a true polarization among respondents on these issues. A scale score was then computed for each factor in Table 1. Items with negative factor loadings were recoded as positive, and the mean response for all items in the factor were computed for each subject. The mean scale scores (± standard error of the mean) by specialty for the Safety Attitudes domain are shown in Table 2.

Impact of Error Domain Scale Psychometrics

The items, descriptive statistics, Cronbach's α, and factor loadings for the error domain are shown in Table 3. A scale score was computed for each factor in Table 3. Items with negative factor loadings were recoded as positive, and the mean response for all items in the factor were computed for each subject. Mean scale scores (± standard error of the mean) by specialty for the Safety Impact of Error domain are shown in Table 4.

Questionnaire Results

Under the factor Teamwork Climate (Table 1), approximately 90% of the respondents agreed that surgeons, anesthesiologists, and perfusionists maintain open communication channels throughout the procedure. A total of 73% of the respondents indicated that disagreements in the operating room (OR) are appropriately resolved. Despite the open communication channels, 29% of the team members responded that they have difficulty speaking up if they perceive a problem with patient care, 41% feel unable to express disagreement, and only 44% report that briefings were routinely carried out before procedures, all of which suggest risks to reliable and safety-oriented communication. Only 45% of the respondents report that morale is high in the OR.

In the factor Safety Climate (Table 1), 82% agree that effective coordination of OR staff requires that the personalities of others be taken into account. Errors were difficult to discuss. Despite the reported open communication channels, only 29% reported that debriefing was common after errors, and only 43% agreed that it is easy to learn from mistakes in the OR. In addition, 60% reported difficulties in discussing mistakes.

In the factor Stress Recognition (Table 1), 94% agreed with the statement "that a high level of workload is common in the OR," and 73% felt that their performance was impacted by an excessive workload and fatigue. Interestingly, 78% of respondents believed that their decision making was unaffected by emergency conditions.

The average scale scores for all the factors in the Safety Attitudes domain for the different specialties are shown in Table 2. The responses differ by analysis of variance only on the Teamwork Climate scale ($p = 0.008$).

In the factors Error Management and Risk Modification of the Impact of Error domain (Table 3), PCS team members report insufficient resources. Only 31% feel that

Table 5. Fictitious Case[a]

Case Management	N	% Agreed	Mean ± SEM
Keep it to myself that the patient has received 10 times the prescribed level	61	3	1.1 ± 0.06
Write in a record that the patient has received 10 times the prescribed level	53	85	3.5 ± 0.12
Talk in confidence with a colleague about the incident	59	75	3.0 ± 0.13
Talk to several colleagues about the incident	59	54	2.58 ± 0.14
Inform my supervisor or the physician in charge of the patient	60	98	3.8 ± 0.08
Report the event to the local reporting system	53	77	3.2 ± 0.13
Tell the family or patient about the problem	53	57	2.8 ± 0.15

[a] A 2-year-old child with hypoplastic left heart syndrome is on the OR table for Fontan surgery. During dissection, the surgeon asks for the heparin to be given in preparation for bypass. While you are preparing the medication, you are distracted by a question from the nurse circulator. You prepare a heparin dose that is 10 times the concentration needed. You do not discover the error until later during the case while discarding the empty bottles. By this time, the patient has received the drug and has had significantly more bleeding than usual, including from intravenous puncture sites, requiring prolonged surgical efforts and massive blood component therapy.

OR = operating room; SEM = standard error of the mean.

Table 6. Concerns Affecting Sleep Patterns

Concerns	Worries (65)	Respondents (37)
1. Fear of making an error or not giving the best care, eg, "forgetting to do something;" "making an error in clinical judgment that adversely affects patient health;" "we left the sponge in the patient"	30 (46%)	19 (51%)
2. Highly complex cases, patient outcome, eg, "exact management of the complex critically ill patient;" "patient outcome"	11 (17%)	10 (27%)
3. Hectic schedule, heavy caseload, eg, "unfair or unrealistic work assignments"	11 (17%)	9 (24%)
4. Other team members' performance, stress during work, external factors, eg, "too much stress at work;" "declining caseload;" "unprofessional behavior by others"	13 (20%)	7 (19%)

levels of staffing are sufficient, and 69% report that problems with equipment are frequent, including equipment that is uncalibrated, malfunctioning, or not available. Only 47% report that equipment is adequate, and only two thirds would feel safe being a patient in their own OR.

In the factor Error Burden of the Impact of Error domain (Table 3), 97% of respondents agree that errors are important regardless of patient outcome. Errors in this environment would appear to be omnipresent, with 91% of the respondents stating they have seen errors, 41% reporting that medical errors happen every day, 83% responding that they have made a mistake that had the potential to harm a patient, and 75% reporting being ashamed of making an error in front of the OR staff. Seeing the same mistake occur repeatedly was reported by 33%. The perceptions of PCS team members about the inadequacy of, and frequent problems with, equipment is reinforced by the fact that 39% agree with the statement that PCS personnel "often ignore guidelines and have a generalized feeling of dread around safety errors."

The average scale scores for all the factors in the Impact of Error domain for the different specialties are shown in Table 4. The responses differ by analysis of variance only on the Error Burden scale ($p = 0.004$).

Clinical Vignette of Adverse Event

The responses to the questions related to the clinical scenario were uniformly positive. Nearly all of the respondents agreed on the need to report the medication error and to discuss the error with colleagues, patient, or family (Table 5). The five items relating to the reporting of error were summed to indicate the likelihood that the respondent would report the error. The overall scale score of the Safety Attitudes domain significantly correlated with the summed score for reporting the error in the clinical scenario ($r = 0.26$; $p = 0.04$). The responses to the questions regarding reporting on events were also found to be significantly correlated to the Error Burden factor in the Impact of Error domain ($r = 0.33$, $p = 0.009$). These correlations suggest that the respondents most likely to report the error would also be those most likely to agree with the burden of error items in the factor.

Table 7. Frequently Occurring Errors Observed by Respondents

Type of Error	Errors (123)	Respondents (50)
Medication error	42 (34%)	30 (60%)
Equipment problems and misuse	28 (23%)	30 (60%)
Communication problem	28 (23%)	23 (46%)
Standards are not followed	25 (20%)	17 (34%)

Open-Ended Questions About the Impact and Burden of Error

The respondents were asked whether they ever had trouble sleeping at night because of worries about their job. Fifty-seven respondents answered this question, with 37 indicating that they sometimes had problems sleeping (65%). They were further asked to list the concerns that interfered with their sleep. The leading cause of provider worries was fear related to their performance inadequacies, closely followed by concerns about the complexity of the tasks faced (Table 6). There were no significant differences across specialties in the frequency of reported sleep concerns. Sleep problems were noted in all specialties at each of the participating institutions.

Only the Error Burden factor scale was associated with loss of sleep. When adjusted for age, sex, years in specialty, and years at hospital by multiple regression, this relationship was statistically significant ($p < 0.03$). The positive relationship of the scale scores with the loss of sleep indicates that the respondents who agreed with the items in the factor were more likely to lose sleep from their concerns about patient welfare. Also, older participants, males, and those with a shorter tenure experience at their hospital were more likely to have higher scale scores on the Error Burden factor. The frequent presence of error and its psychological impact and stresses from overwork suggest that these concerns impact clinicians even when they are away from work.

Respondents were also asked to list three frequently occurring errors they had personally observed. The reported errors, shown in Table 7, were categorized by the type of error. The most frequent type was a medication error. Errors caused by deficits in knowledge were less

frequent. These observations validate the concerns raised by the items in the Error Burden factor (Table 3).

Finally, the respondents were asked to list up to three recommendations for improving patient safety. The top two recommendations were improving team communications and increasing education and training. These recommendations reflect the concerns expressed in both the Teamwork Climate and Safety Climate factors (Table 1).

Comment

We studied surgery teams working in a high-stress environment to assess attitudes and perceptions of team members toward patient safety. We found that the actuality and anticipation of clinical error imposes a measurable burden on the PCS team. Because there is no ideal safety culture profile, and no database exists to compare results against organizations with the best safety practices [20], we chose to interpret our data following the methods of the safety culture study of 15 California hospitals [21]. This study indicated responses were "problematic" if they show a substantial percentage of responses in the undesired direction [21–23].

On a positive note, we found that most team members value safety concerns and have an increasing awareness to these issues. There was nearly unanimous support for the statement "when errors are committed patient safety is important regardless of the patient outcome." This finding is confirmed by the responses to a clinical scenario in which nearly all responded in a way indicative of a concern for safety. This also points to the growing awareness of the need to report and learn from near-miss opportunities.

The item responses in the Safety Attitude domain are perplexing. Our study found that the PCS team's Safety Attitudes have the same characteristics as safety culture studies describing other health care teams [24, 25]. The teamwork climate was characterized as having open channels of communication, but a substantial portion of the team feels that they are unable to express disagreement, and professional disagreements are not resolved. We found that only one half of the respondents reported presurgery briefing, and only one third of the respondents indicated that debriefing occurs after errors and patient harm. Only a small percentage of our respondents feel that it is easy to learn from their own mistakes, suggesting that many do not have the knowledge or the tools to analyze the causes of these errors. A troubling finding from the Teamwork Climate items is that 55% of respondents agreed that morale is low in their OR. Clearly, morale has many elements but essentially reflects the emotional attitude of an individual to group expectations and loyalty to the group [25]. The high factor loading of the Teamwork Climate factor indicates that work is needed with respect to establishing better rapport among team members and setting realistic team expectations.

Many of the errors and adverse events reported in this study relate to the need to address the human factors underlying these events. The fact that only 64% of the respondents would feel safe as a patient in their own OR raises concerns and suggests that important underlying elements of a safe climate are perceived to be missing. The perceptions of PCS team members about the inadequacy of equipment are troublesome. This study demonstrated that team members perceive a high level of workload, and more than 70% of the respondents feel that excessive workload and fatigue adversely affect their performance, which is of concern in the frequently high-risk context of PCS. This is in contrast to Sexton and coworkers [4], who found in their comparison of medicine and aviation that only 40% of medical respondents agreed with this question whereas 74% of pilots agreed. Perhaps the increased awareness and education regarding these issues in the ensuing years have altered these attitudes, or the high-risk profile of the PCS environment increases the awareness of this vulnerability.

Perhaps the most troubling finding is the fact that 33% of respondents have seen the same mistake occur repeatedly. This points to a real failure of current systems to prevent errors from occurring again. The PCS team members perceive human error, both their own and that of others, to be ubiquitous. Respondents indicate that they know the proper channels to report patient safety concerns but often do not report these events. This dissonance points to the reluctance providers have about sharing these events with management and their colleagues.

The recommendations to improve patient safety point to clear intervention opportunities, as do the reportedly infrequent team briefings before and after procedures that included patient harm. Only a small percentage of our respondents feel that it is easy to learn from their own mistakes, suggesting that many may not have the knowledge or the skills to analyze the root causes of these errors. Educational sessions dedicated to root-cause analysis and safety science may provide another important opportunity.

We recognize several limitations to the study. The limited scope and sample size of PCS teams require that these findings be further validated. However, the successful fit of the confirmatory factor analysis based on a previously validated study [17] appears to lend credibility to the belief that relatively small sample sizes can be used to accurately measure previously described patient safety concepts. The validation of the hypothesized factor structure of the Impact of Error domain was more modest than for the established items, but still acceptable for identifying the attitudes and concerns of team members. Focusing on clinician perceptions based on preformulated questions may be a source of richness but also have unrecognized biases. Further development of the methodology to understand attitudes and their impact on actual provider performance, perhaps coupled with empirical and observational techniques [24], to measure these burdens would help confirm the generalizability of the results.

In conclusion, the findings suggest that PCS teams face significant barriers in enabling the conditions for safe

outcomes and deserve careful study. These findings highlight the personal and professional burden that the fear and recognition of errors puts on team members and their impact on the performance and mindset of health care providers.

Providers' reluctance to share safety events with others limits learning in this important arena. The perceived powerlessness of team members to prevent safety events must be addressed as part of an overall strategy to improve patient care outcomes. The study points to the need to address teamwork culture and highlights opportunities for safety improvement in the context of PCS.

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