Medical Care Research and Review
1–26

DOI: 10.1177/1077558715577479
mcr.sagepub.com
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Surgical Team Member Assessment of the Safety of Surgery Practice in 38 South Carolina Hospitals

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Abstract

We assessed surgical team member perceptions of multiple dimensions of safe surgical practice in 38 South Carolina hospitals participating in a statewide initiative to implement surgical safety checklists. Primary data were collected using a novel 35-item survey. We calculated the percentage of 1,852 respondents with strongly positive, positive, and neutral/negative responses about the safety of surgical practice, compared results by hospital and professional discipline, and examined how readiness, teamwork, and adherence related to staff perception of care quality. Overall, 78% of responses were positive about surgical safety at respondent's hospitals, but in each survey dimension, from 16% to 40% of responses were neutral/negative, suggesting significant opportunity to improve surgical safety. Respondents not reporting they would feel safe being treated in their operating rooms varied from 0% to 57% among hospitals. Surgeons responded more positively than nonsurgeons. Readiness, teamwork, and practice adherence related directly to staff perceptions of patient safety ($p < .001$).

This article, submitted to *Medical Care Research and Review* on August 4, 2014, was revised and accepted for publication on January 9, 2015.

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Keywords
survey, surgery, checklist, implementation, health delivery innovation

Introduction

Two thirds of safety problems in hospitals involve surgical patients and half of those may be preventable (Gawande, Thomas, Zinner, & Brennan, 1999). In operating rooms, errors have the potential for catastrophic consequences. The incidence of operating on the wrong site, performing the wrong procedure, failing to confirm blood type compatibility in transfusions, and overlooking allergies remains alarmingly common (Mehtsun, Ibrahim, Diener-West, Pronovost, & Makary, 2013). Better teamwork and adherence to practices known to enhance patient safety can prevent many errors (Haynes et al., 2011).

A variety of innovations based on checklists (de Vries et al., 2010; Haynes et al., 2009; Lingard et al., 2008), communication and leadership (e.g., crew resource management; Awad et al., 2005; Dunn et al., 2007; McGreevy et al., 2006), and teamwork training (e.g., TeamSTEPPS; Forse, Bramble, & McQuillan, 2011; Weaver et al., 2010) have sought to improve team-based care and compliance with safe practice guidelines. Multiple studies have shown the potential for these innovations to reduce surgical complications and perioperative mortality (de Vries et al., 2010; Forse et al., 2011; Haynes et al., 2009).

However, effectively implementing patient safety innovations like these is challenging and has shown highly variable results (Conley, Singer, Edmondson, Berry, & Gawande, 2011). Implementation may be difficult because the operating room climate is hostile to innovation, longstanding interpersonal hierarchies undermine team-based approaches, or individuals resist changing habitual practice (Treadwell, Lucas, & Tsou, 2013). Effective implementation is nevertheless critical for achieving the benefits of an innovation (Klein, Conn, & Sorra, 2001). With regard to checklists, evidence supports a dose effect, with better compliance associated with greater improvement (de Vries et al., 2010; van Klei et al., 2012). Although many studies suggest high compliance with checklist use, several also report that relatively few items on the list are actually completed (Fourcade, Blache, Grenier, Bourgain, & Minvielle, 2012; Kasatpibal et al., 2012; Levy et al., 2012). This suggests that poor implementation can turn well-intentioned interventions into ineffective, rote box-ticking exercises (Vats et al., 2010).

Organizational readiness is a key determinant of effective implementation (Weiner, 2009). By implementing patient safety innovations, hospitals seek to improve current team climate, individual practices, and anticipated outcomes (Haynes et al., 2011; Singer & Vogus, 2013a). Understanding current levels of organizational readiness, teamwork, adherence to, and consequences of safe surgical practice can help guide implementation leaders in developing strategies for more effective uptake of patient safety innovations and provide feedback about implementation effectiveness (Singer & Vogus, 2013b).

The purpose of this study was to inform implementation of surgical checklists by assessing surgical team member perceptions of readiness, teamwork, adherence to, and consequences of safe surgical practice in a diverse sample of 38 hospitals, accounting for approximately 66% of the surgical volume in South Carolina. Participating hospitals conducted this survey as one component of a statewide initiative to implement and evaluate a customized version of the World Health Organization's Surgical Safety Checklist. Each hospital received a benchmarked report and guidance on how to leverage their survey results for the purposes of motivating and informing their checklist implementation. In this article, we compare baseline survey results by hospital and professional discipline and examine how other dimensions relate to perceived consequences.

New Contribution

For this study, we developed a new surgical safety survey instrument to provide a baseline assessment of key constructs of interest for implementing patient safety innovations like surgical safety checklists. A companion instrument—not the subject of this article (available on request from the corresponding author)—was designed to assess implementation effectiveness by comparing results with baseline measures.

In addition to assessing the reliability and validity of our instrument, we explore responses to the baseline survey among operating room personnel overall as well as both among hospitals and among professional disciplines. This provides the first assessment of surgical innovation readiness, teamwork, safe practice, and perceived consequences in a large and diverse sample of U.S. hospitals.

Conceptual Framework

The conceptual model underlying our study draws on prior research about factors associated with successful implementation of innovations and improvement initiatives (Damschroder et al., 2009; Edmondson, Bohmer, & Pisano, 2001; Forum on the Science of Health Care Quality and Improvement, 2007; Greenhalgh, Robert, Macfarlane, Bate, & Kyriakidou, 2004; Kitson et al., 2008; Klein et al., 2001), qualitative investigation of factors affecting surgical checklist implementation, and in-depth study of the program promoting checklist implementation in South Carolina (www.safesurgery2015.org). We identified four overarching dimensions deemed to be of greatest interest in the surgical environment and more feasible to obtain through staff survey than other forms of data collection: contextual, interpersonal, practical, and consequential.

First, the contextual dimension asks how ready the organization is for undertaking the initiative; that is, how fertile is the soil into which the innovation will be introduced. Readiness includes, but is not limited to, experience implementing similar innovations, staff attitudes toward the innovation, belief that it is important for patient safety, and the cooperation among multiple disciplines in support of implementation (Weiner, 2009). Information about potential receptivity problems for the innovation can alert hospitals to the need for action to ensure a more hospitable environment.

Second, the interpersonal dimension recognizes that implementing innovations, even those as outwardly straightforward as surgical checklists, requires complex social and behavioral changes that challenge the status quo (Barley, 1986). Surgical checklists encourage nonhierarchical, team-based interaction, enhanced communication, anticipation of potential complications, and means for responding to them. In short, they aim to foster effective teamwork (Treadwell et al., 2013). Thus, building on previous models of teamwork (Valentine, Nembhard, & Edmondson, 2014), we define five measurable interpersonal factors that may affect and be affected by surgical innovations: communication, coordination, respect, assertiveness, and clinical leadership. Communication refers to how well team members share information and listen; coordination addresses how well they work together; respect refers to whether team members feel valued and appreciated; assertiveness addresses the extent to which it is easy for team members to speak up, ask for help, or discuss mistakes; and clinical leadership asks whether the physicians on the team—surgeons and anesthesiologists—are seen as good leaders.

The third dimension is the practical dimension; it refers to the extent to which surgical team members adhere to established safety practices in the operating room (e.g., preoperative planning for potential problems and postoperative debriefing on key concerns for patient recovery and management). Finally, the consequential dimension measures perceived impact of the innovation on surgical outcomes as perceived by team members (e.g., how safe team members would feel being treated as patients in their own operating rooms).

By portraying the baseline status of factors we expect the innovation to affect (interpersonal, practical, and consequential), our intention is to motivate openness to using the innovation and to inform the actions of those seeking to implement it. In our conceptual model, we hypothesize that the first three dimensions, representing readiness, teamwork, and adherence to safe practice, will be related to perceived consequences of safe operating room practice, and ultimately to improved patient safety.

Method

Survey Instrument

The survey instrument was constructed with reference to existing surveys (Makary et al., 2006; Sexton et al., 2006; Singer et al., 2007; Sorra & Nieva, 2003). In weekly meetings, project investigators discussed and revised items based on feedback about individual items or the survey as a whole from experts in checklist implementation and survey measurement and from frontline nurses and physicians and on consultation with the literature. In choosing a final set of items, we sought to ensure a sufficient number and breadth of items to represent the four theoretical dimensions of our conceptual framework. The final survey included 35 items plus 9 demographic items.

Five items asked about contextual issues to assess the readiness of the surgical unit for implementing the checklist (e.g., “In the ORs where I work, surgical team members are open to changes that improve patient safety, even if it means slowing down”).

The interpersonal dimension included 22 items addressing the five aforementioned teamwork factors. For example, the item, "In the ORs where I work, surgical team members share key information as it becomes available," addressed communication. The survey also included five items assessing whether safe practices are routinely performed (e.g., "In the ORs where I work, for complex patients or cases, preoperative briefings always include planning for potential problems") and three items regarding consequences of surgical practice (e.g., "I would feel safe being treated here as a patient"). All items used a 7-point Likert-type scale ranging from 1 = *strongly disagree* to 7 = *strongly agree*. With the exception of the three questions about consequences, all items were asked in the context of the participant's work area (i.e., statements began with, "In the ORs where I work"). Questions were carefully worded to be always applicable to respondents' work situations; therefore, N/A was not provided as an answer choice.

Demographic questions captured information about respondents' age, gender, race, and ethnicity. Each item offered multiple-choice options, including "Decline to answer." Additional items assessed respondents' primary professional role (e.g., Surgeon, Anesthesiologist, Certified Registered Nurse Anesthetist [CRNA], etc.) and number of years in that role. We identified respondents' surgical service by asking them to indicate from a list all services the one in which they work most. Last, the survey asked if the respondent was (or would be) the person or one of the people responsible for checklist implementation in their hospital.

Survey Sample

At each participating hospital, the target sample was 100% of surgical team members who would be present for the performance of a checklist should it occur, including clinical staff (surgeons, anesthesia professionals, surgical technicians, circulating nurses, and others) and clinical and administrative managers. Other operating room personnel, such as sterile processors and other support staff, were not included in our sample. In total, our sample included 4,932 individuals. For our analysis, respondents identifying as surgeons and physician assistants were considered surgeons. We also distinguished among anesthesiologists, CRNAs, surgical nurses, surgical technicians, and others.

All study procedures were developed in collaboration with the South Carolina Hospital Association and approved by the Human Subjects Committees of the Harvard T.H. Chan School of Public Health and participating hospitals.

Survey Administration Procedures

The survey was administered as part of the Safe Surgery 2015 initiative to provide baseline data for participating hospitals for the purposes of highlighting opportunities for improvement and informing the implementation efforts at each hospital. All 67 hospitals conducting surgical procedures in the state agreed to participate. Of these, 53 have participated so far in the checklist implementation program over three waves.

This study draws on data from 38 hospitals that used consistent procedures in administering the survey. Remaining hospitals declined to conduct a survey or to share their data or did so long after the other hospitals. Among the 38 hospitals we consider in this study, 23 hospitals began their implementation in the first wave (April 2011-August 2011), 11 started in the second (November 2011-April 2012), and 4 started in the third (November 2012-April 2013).

Each participating hospital assigned a site manager who provided a list of all operating room personnel, their official titles, and, if possible, their e-mail addresses. Using these lists, surveys were administered between June 2011 and May 2013 through one or both of the following procedures: (a) a personalized e-mail with at least two follow-ups at 8-day intervals and (b) a paper-based survey, distributed and collected by the site manager. The paper and online versions contained identical questions, all in English. A data input firm processed paper surveys and returned a raw comma-delimited file, which was merged with automated output from online surveys.

Multiple Imputation

Exploratory analysis of our data revealed that average item nonresponse was 1.74%. For individual items, nonresponse ranged from 0.32% to 8.96%. To determine the extent to which missing items would bias our results, we conducted a sensitivity analysis comparing results based on the original data with results based on complete data generated using multiple imputation by chained equations (He, Zaslavsky, Landrum, Harrington, & Catalano, 2010). Results were similar. Therefore, for simplicity in this article, we present all results-based analysis of the original data set. Results derived using the complete data set are available on request from the corresponding author.

Data Analysis

First, we conducted exploratory and confirmatory psychometric analysis on items included in the interpersonal dimension to assess its latent structure. After checking the data for normality, we randomly split the sample into derivation ($n = 926$) and validation halves ($n = 926$). Demographic differences between halves were nonsignificant (see Table 1).

Using the derivation sample, we conducted exploratory factor analysis with a promax rotation, which assumes factors are correlated rather than orthogonal (Hendrickson & White, 1964). We determined the number of factors to extract based on eigenvalues (Kaiser, 1960) and factor slopes plotted against their eigenvalues (Cattell, 1966). We assessed reliability by measuring internal consistency (Cronbach's alpha) and convergent and discriminant validity by examining the strength of each item's correlation with its assigned scale and comparing it with its correlations with the remaining scales (Hays & Hayashi, 1990). A scale score was calculated as the average loading of items with at least 0.30 for a given factor (Stevens, 2012). We evaluated items theoretically to consider their relationship to the intended construct, and identified items that could be dropped without reducing scale quality.

Table 1. Demographics of the Total, Derivation, and Validation Samples.

	Total		Derivation subsample		Validation subsample	
	(*N* = 1,852)		(*n* = 926)		(*n* = 926)	
Professional role						
Surgeons[a]	391	21.3%	196	21.4%	195	21.2%
Anesthesiologists	115	6.3%	60	6.6%	55	6.0%
Certified registered nurse anesthetist	254	13.7%	130	14.2%	124	13.5%
Surgical nurse	544	29.4%	265	28.9%	279	30.4%
Surgical technician	337	18.4%	170	18.6%	167	18.2%
Other	194	10.6%	95	10.4%	99	10.8%
Years of experience in role						
<1	102	5.6%	42	4.6%	60	6.6%
1-5	387	21.2%	210	23.0%	177	19.4%
6-10	314	17.2%	148	16.2%	166	18.2%
>10	1,023	56.0%	515	56.3%	508	55.8%
Gender						
Male	642	34.7%	326	35.2%	316	34.1%
Female	1,105	59.7%	544	58.8%	561	60.6%
Decline to answer	105	5.7%	56	6.1%	49	5.3%
Age (years)						
18-25	58	3.1%	25	2.7%	33	3.6%
26-35	302	16.3%	150	16.2%	152	16.4%
36-45	479	25.8%	241	26.0%	238	25.7%
46-55	567	30.6%	292	31.5%	275	29.7%
>55	353	19.1%	169	18.3%	184	19.9%
Decline to answer	93	5.0%	48	4.8%	49	5.3%
Hispanic						
Yes	30	1.6%	17	1.8%	13	1.4%
No	1,656	89.4%	824	89%	832	90%
Decline to answer	123	6.6%	62	6.7%	61	6.6%
Unknown	43	2.3%	23	2.5%	20	2.2%
Race						
American Indian or Alaska native	8	0.4%	4	0.4%	4	0.4%
Asian or Pacific Islander	32	1.7%	10	1.1%	22	2.4%
Black or African American	144	7.8%	78	8.4%	66	7.1%
White	1,450	78.3%	727	78.5%	723	78.1%
Multiracial	18	1.0%	7	0.8%	11	1.2%
Decline to answer	153	8.3%	73	7.9%	80	8.6%
Unknown	47	2.5%	27	2.9%	20	2.2%

Note. No statistically significant differences between subsamples.
a. Includes eight physician assistants, whose inclusion in this category does not affect results.

We tested our factor model by performing confirmatory factor analysis on the validation half-sample using maximum likelihood estimation. In evaluating the fit of the factor model, we applied criteria recommended by Brown (2006).

We calculated scores for each factor comprising the interpersonal dimension as the unweighted average of factor items; however, we also summarized the interpersonal

dimension by averaging factor scores. We treated the contextual and practical dimensions of the survey as simple indices (unweighted averages) and the three consequential items both as an index and as individual outcome measures. All analyses were performed using SAS 9.3.

Given the skew of responses toward the higher end of the response scale, we report the percentage of strongly positive (7 after reverse-scoring negatively worded items), positive (5-6), and neutral or negative responses (1-4). Combining neutral and negative responses assumes neutral responses may imply a weak climate (Singer et al., 2003). For the dimensions and factors, average scores <4.5 were classified as negative/neutral, 4.5 to 6.5 as positive, and >6.5 strongly positive.

We analyzed responses to individual items and dimensions/factors overall, by respondent hospital, and by professional discipline. We confirmed that aggregation to the hospital level was appropriate by calculating intraclass correlation coefficients. While not every construct achieved levels of intraclass correlation typically considered sufficient for aggregation (Snijders & Bosker, 1999), intraclass correlation coefficients ranging from 0.56 to 0.81 for assertiveness and coordination, respectively, generally supported aggregation. To test for differences in responses across professional disciplines, we used analysis of variance.

Finally, as a means of establishing criterion validity, we examined the relationship between perceptions of hospital readiness, teamwork, and safe practice with perceived consequences of safe practice in the operating room using multilevel random effects models. We considered each of the three items comprising the consequential dimension as dependent variables. Separate models considered the three dimensions together, the interpersonal dimension alone, and the five interpersonal factors as a group (i.e., three models per dependent variable). Models also controlled for respondent characteristics. Ideally, we would have also included survey return date to adjust for potential respondent bias, but we did not consistently have this information because surveys administered on paper were often returned in batches.

Results

Sample Characteristics

Of 4,932 individuals in our sample, 2,038 responded, ranging from 7 to 152 per hospital. The response rate was 58% for nonphysicians, 29% for physicians, and 41% overall. Response rates by hospital ranged from 15% to 100%. Higher response rate was significantly related to more positive responses. We excluded respondents who completed less than half the survey, resulting in a final analytical data set with 1,852 individuals.

Respondents included 29% surgical nurses, 21% surgeons, 20% anesthesia professionals (6% anesthesiologists and 14% CRNAs), 18% surgical technicians, and 11% other personnel (see Table 1). Of surgical team members who provided demographic information, a majority (56%) had more than 10 years of experience in their role and approximately two-thirds (63%) were female. Respondents were predominantly at least 36 years of age (80%); 22% were non-White, and 2% self-identified as Hispanic or Latino.

Psychometric Analysis for Interpersonal Dimension

Applying Kaiser's eigenvalues-greater-than-one rule and Catell's scree test to the 22 interpersonal items in the survey, we retained four factors related to various elements of teamwork (see Appendix A-1). The first factor included 11 items pertaining to communication, coordination, assertiveness, and clinical leadership; the second, third, and fourth scales included four, three, and three items, respectively, related to respect, assertiveness, and clinical leadership. Removal of two questions deemed to have low relevance, little effect on scale internal consistency, and scaling problems (high correlation with scales other than those assigned or similar correlation on multiple scales) left 16 items. Given theoretical justification for dividing remaining items in the first factor, its relatively long length, and the modest average covariance of items with the scale, we treated communication and coordination as latent subscales, resulting in a five-factor model. Scales showed internal reliability estimates ranging from 0.71 (leadership) to 0.92 (respect), all at or above conventional standards (see Appendix A-2). Means and standard deviations for the derivation and validation halves were similar, suggesting that randomly splitting samples resulted in comparable groups.

Using the validation sample, we conducted confirmatory factor analysis to test our ability to replicate the five-factor, 16-item model for the interpersonal dimension. Factor loadings and fit indices both support the five-factor model. The root mean square residual was 0.04 and comparative fit index was 0.95, both considered exceptional (Brown, 2006); goodness-of-fit and adjusted goodness-of-fit were both adequate at 0.92 and 0.90 respectively, as was root mean square error of approximation at 0.06 confidence interval [0.059, 0.0699]. Correlations among factors comprising the interpersonal dimension and the contextual, practical, and consequential indices, ranging from 0.46 to 0.76, were relatively high (see Appendix A-2). However, they were lower than corresponding alpha coefficients, suggesting the factors measured related yet distinct aspects of team members' perceptions of teamwork.

Perceptions Among Operating Room Personnel

As with most safety climate surveys (Sexton et al., 2006; Singer et al., 2009; Sorra & Nieva, 2012), responses were predominantly positive: 78% positive or strongly positive overall (see Table 2). Among survey dimensions, the dimension addressing safe surgical practice had the highest percentage of respondents whose average score among items was negative or neutral (i.e., inconsistent with safety) at 40%. For example, 56% of surgical team members indicated that postoperative debriefings did not always include discussion of key concerns for patient recovery and postoperative management. Of teamwork factors, clinical leadership had the highest percentage of respondents whose average score for the dimension was suggestive of potential problems, with 38% negative/neutral response, while assertiveness had the lowest at 22%. For all but one teamwork item, at least 20% of responses were negative/neutral. Of the consequences of surgical practice the survey measured, pressure to move quickly from case to case hindering patient safety was most commonly problematic, with 56%

Table 2. Surgical Safety Culture Results, Overall, by Dimensions, Factors, and Items.

	Negative or neutral response (1-4)		Agree (5-6)		Strongly agree (7)	
	n	%	*n*	%	*n*	%
Overall (all survey items)		21.6		69.2		9.2
Dimension/*factor*/item						
Contextual (readiness)		16.7		64.3		19.0
Q1. Surgical team members are open to changes that improve patient safety, even if it means slowing down.	546	29.7	794	43.1	501	27.2
Q2. The Joint Commission "Time Out" is used in every case by every surgical team.	95	5.1	309	16.7	1,441	78.1
Q3[r]. The Joint Commission "Time Out" was difficult to implement.	642	35.0	634	34.6	558	30.4
Q4. Surgical team members all agree on the importance of using checklists in surgery.	470	25.7	739	40.4	619	33.9
Q5[r]. Interest in checklist implementation is limited to one profession (e.g., surgery, anesthesia, or nursing).	605	33.4	637	35.2	568	31.4
Interpersonal (teamwork)		24.9		62.9		12.2
Factor 1: Communications		32.0		53.0		15.1
Q10. Team discussions (e.g., briefings or debriefings) are common.	831	45.3	674	36.7	330	18.0
Q12. Surgical team members make sure their comments or instructions are heard.	556	30.3	890	48.5	389	21.2
Q13. Surgical team members share key information as it becomes available.	460	25.0	891	48.5	486	26.5
Factor 2: Coordination		24.3		58.5		17.2
Q14. Surgical team members appear eager to help one another.	463	25.1	898	48.8	481	26.1
Q15. Physicians and nurses work together as a well-coordinated team.	441	24.0	936	50.9	461	25.1
Q16. Surgeons and anesthesia providers work together as a well-coordinated team.	389	21.1	962	52.3	490	26.6
Q17. Surgical team members from different disciplines always discuss patients' conditions and the progress of operations.	760	45.1	697	41.3	229	13.6
Q18. Plans for patient care are adapted as needed.	286	16.8	938	55.0	481	28.2
Factor 3: Respect		26.6		55.2		18.3
Q24. Surgical team members communicate with me in a respectful manner.	398	21.6	960	52.1	486	26.4
Q25. My input about patient care is well received by other surgical team members.	369	20.0	964	52.3	510	27.7
Q26. I am always treated as a valuable member of the surgical team.	435	23.6	846	45.9	561	30.5
Q27. Potential errors or mistakes are pointed out without raised voices or condescending remarks.	679	36.9	881	47.9	280	15.2

(continued)

Table 2. (continued)

	Negative or neutral response (1-4)		Agree (5-6)		Strongly agree (7)	
	n	%	*n*	%	*n*	%
Factor 4: Assertiveness		22.1		49.9		28.0
Q7r. It is difficult to discuss medical mistakes.	567	30.9	697	38.0	571	31.1
Q8r. Surgical team members appear to struggle and do not ask one another for help.	391	21.5	769	42.4	655	36.1
Q9r. It is difficult to speak up when I perceive problems with patient care.	408	22.2	701	38.1	729	39.7
Factor 5: Clinical Leadership		37.8		48.5		13.8
Q19r. Physicians are only open to suggestions from other physicians.	695	38.3	781	43.0	340	18.7
Q22. Physicians are present and actively participating in patient care prior to skin incision.	612	35.7	638	37.2	463	27.0
Q23. Physicians maintain a positive tone throughout operations.	758	41.3	829	45.1	250	13.6
Practical (adherence)		40.4		51.2		8.5
Q28r. Surgical team members refer to each other by role instead of name (e.g., "Nurse" instead of "Dana").	284	15.8	626	34.8	891	49.5
Q29. Surgical teams always discuss the operative plan (i.e., more than the location of the incision and name of the procedure) before incision.	788	43.2	674	36.9	364	19.9
Q30. For complex patients or cases, preoperative briefings always include planning for potential problems.	810	44.7	692	38.1	312	17.2
Q31. Postoperative debriefings always include a discussion of key concerns for patient recovery and post-op management.	1,012	56.0	578	32.0	216	12.0
Q32. Equipment issues or other problems discussed in postoperative debriefings are addressed in a timely manner.	798	44.1	731	40.4	279	15.4
Consequential (other items)		16.2		63.8		20.0
Q33. I would feel safe being treated here as a patient.	267	14.6	803	43.8	762	41.6
Q34. If I were having an operation, I would want a surgical safety checklist to be used.	133	7.3	458	25.1	1,237	67.7
Q35r. Pressure to move quickly from case to case gets in the way of patient safety.	1,024	56.2	450	24.7	349	19.1

Note. Items removed due to low relevance, little effect on scale internal consistency, and scaling problems included the following:
Q6: I am encouraged to report any patient safety concerns I may have.
Q11: Communication breakdowns frequently lead to delays in starting surgical procedures.
r. Item was reverse scored.

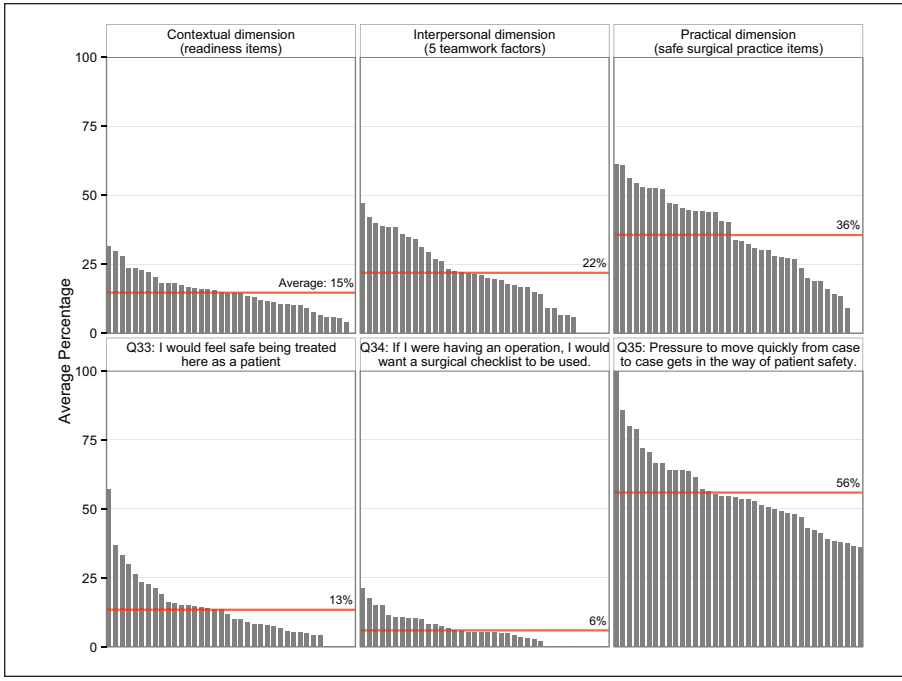

Figure 1. Average percentage of negative and neutral responses by hospital and across hospitals.

negative/neutral response. Comparatively few respondents indicated they felt neutral or would not want a surgical checklist to be used if they were having an operation (7%), suggesting production pressure may interfere with patient safety even when providers desire to perform safe care. In addition, 15% of respondents overall felt at best neutral when asked whether they would feel safe as a patient in their own ORs.

Differences Among Hospitals

For all survey dimensions, the average percentage of negative and neutral responses varied widely among hospitals (see Figure 1). The percentage of respondents whose average score was negative/neutral responses for the contextual dimension ranged from 0% (best) to 32% (worst), 15% on average across hospitals. For the interpersonal dimension, the percentage of respondents whose average score was negative/neutral ranged from 0% to 47%, 22% on average across hospitals. The greatest variation among hospitals was for the leadership factor (results not shown). For the practical dimension, hospitals ranged from 0% to 61% average negative/neutral responses, 36% across hospitals. The percentage in each hospital reporting they would feel neutral or unsafe as a patient varied from 0% to 57%, with average of 13%. The range in

respondents, suggesting pressure to move quickly between cases, may have impeded patient safety was from 36% to 100%, 56% on average. In contrast, the percentage of respondents who were negative/neutral about wanting a surgical checklist to be used if they were having an operation ranged from 0% to 21%, 6% on average.

Differences Among Professional Disciplines

Comparing across disciplines, rates of negative/neutral responses were consistently lower among physicians (surgeons and anesthesiologists) than among other professional disciplines, particularly nurses (CRNAs and other nurses; see Figure 2). However, these differences between physicians and other staff were most pronounced with regard to two of the five teamwork factors within the interpersonal dimension (leadership and respect). In addition, surgeons differed markedly from other staff regarding one consequence (whether the respondent felt production pressure hindered patient safety). Surgeons were also significantly more likely than other professions to feel neutral or worse toward having a checklist used if they were having an operation. With regard to leadership, less than 20% of physicians on average were negative/neutral, while the percentage of negative/neutral responses among others was two to three times as high ($p < .001$). For respect, less than 10% of physicians on average were negative/neutral, while others were at least three times as negative/neutral ($p < .001$). Similarly, with less than 20% negative/neutral responses, surgeons were approximately three times less concerned than their colleagues regarding potential consequences of time pressure on patient safety ($p < .001$).

Relationship of Teamwork, Readiness, and Adherence With Perceived Consequences of Safe Operating Room Practice

Teamwork was consistently related to perceived consequences of safe practice in the operating room when considered alone in regressions controlling for demographic characteristics (see Table 3, Models 1, 4, and 7; $p < .001$). A 1-point higher response on the 7-point teamwork scale on average was associated with a .84 higher response for feeling safe as a patient in the respondent's own operating rooms, a .27 higher response for wanting a checklist used if the respondent were a patient, and a .57 lower response for feeling that production pressure affects patient safety. Effect sizes (i.e., coefficient * standard deviation for independent variable/mean for dependent variable) were small: 16% for feeling safe, 15% for feeling pressure, and 5% for wanting a checklist used. Many of the individual factors comprising the interpersonal dimension were also associated with perceived consequences of safe operating room practice (Models 2, 5, and 8). Perceptions of coordination, respect, and assertiveness positively related to feeling safer as a patient. Higher scores for coordination, respect, and communication also related to wanting a checklist to be used. Assertiveness and leadership negatively related to feeling pressure affects patient safety. That is, respondents who felt more positively about leadership and assertiveness in the operating room felt less that production pressure interfered with patient safety. When we combined

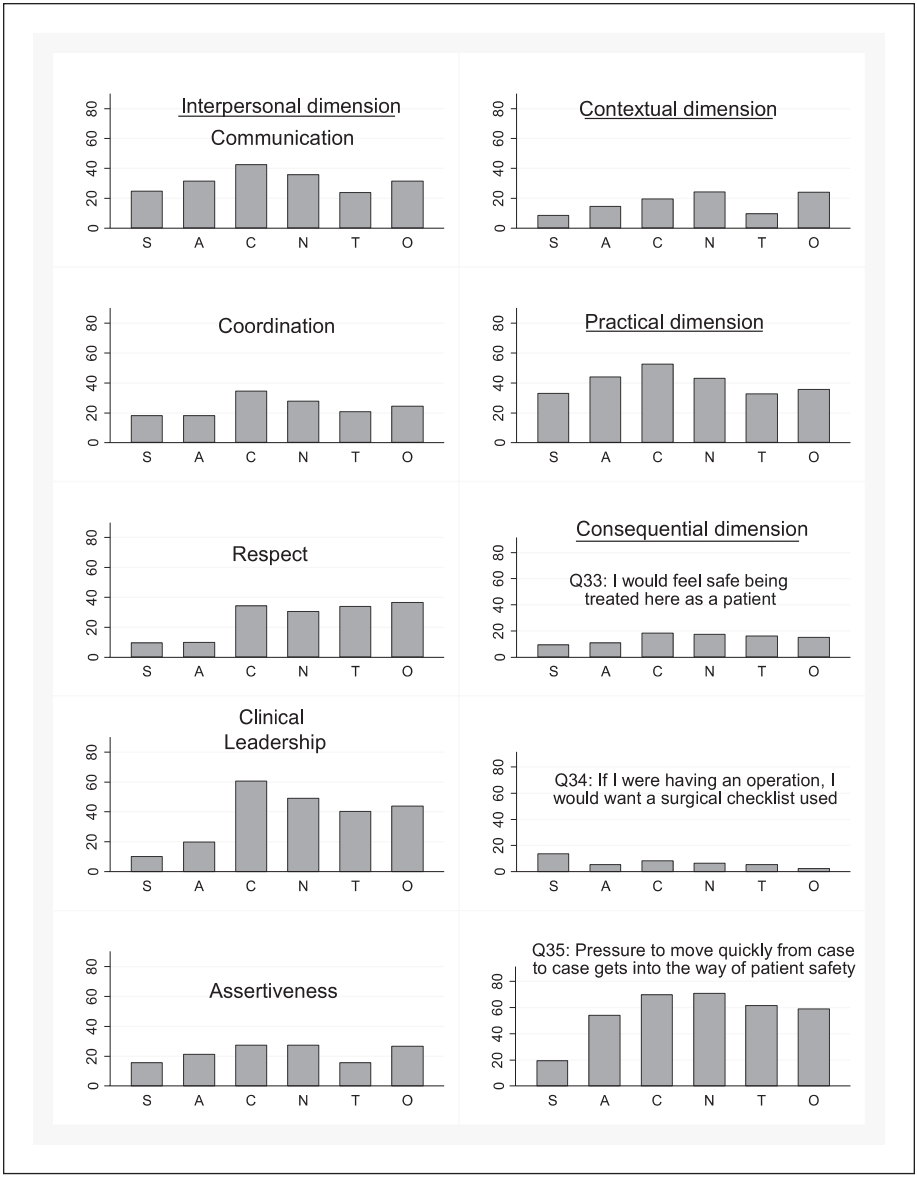

Figure 2. Average percentage of negative or neutral responses by professional discipline.
Note. S = surgeon (including eight physician assistants); A = anesthesiologist; C = certified registered nurse anesthetist; N = surgical nurse; T = surgical technician; O = other.

interpersonal, contextual, and practical factors in the same regressions (Models 3, 6, and 9), we found that all three—teamwork, readiness, and adherence to safe

Table 3. Relationship of Teamwork and Perceptual Consequences of Safe Operating Room Practice.

	Percent of responses indicating positive response to question as worded								
	Would feel safe here as patient			If me, would want checklist used			Pressure gets in way of patient safety		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Dimension									
Interpersonal (teamwork)	0.838***		0.706***	0.268***		0.042	−0.565***		−0.396***
	(0.048)		(0.06)	(0.035)		(0.052)	(0.044)		(0.059)
Contextual (readiness)			0.105*			0.295***			−0.239***
			(0.042)			(0.05)			(0.058)
Practical (adherence)			0.081*			0.04			−0.036
			(0.036)			(0.047)			(0.057)
Interpersonal factor									
Communication		0.083			0.0910*			−0.081	
		(0.053)			(0.034)			(0.062)	
Coordination		0.205**			0.104**			0.145	
		(0.073)			(0.034)			(0.090)	
Respect		0.356***			0.156***			−0.100	
		(0.046)			(0.041)			(0.080)	
Assertiveness		0.107***			−0.040			−0.271***	
		(0.024)			(0.030)			0.038	
Clinical Leadership		0.032			−0.060^			−0.292***	
		(0.056)			(0.040)			(0.040)	
Constant	1.070*	1.086**	0.792^	5.111***	5.22***	4.509***	6.124***	6.270	6.577***
	(0.457)	(0.445)	(0.464)	(0.378)	(0.380)	(0.487)	(0.694)	(0.680)	(0.737)
Observations	1,477	1,477	1,411	1,474	1,474	1,408	1,471	1,471	1,405
Degrees of freedom	*F*(10, 1466)	*F*(14, 1462)	*F*(12, 1398)	*F*(10, 1463)	*F*(14, 1459)	*F*(12, 1395)	*F*(10, 1460)	*F*(14, 1456)	*F*(12, 1392)
F statistic	130.17***	97.41***	107.24***	16.13***	13.67***	19.49***	38.10***	30.33***	32.72***
Adjusted R^2	0.467	0.478	0.4748	0.093	0.108	0.1362	0.201	0.218	0.213

Note. Robust standard errors in parentheses. Results are given as coefficients, derived from two-level random effects models that account for nesting of respondents within hospitals. Models also control for age, sex, race, ethnicity, primary professional role, and number of years in that role.
***$p < .001$. **$p < .01$. *$p < .05$. ^$p < .10$.

practice—significantly related to feeling safer as a patient, while readiness was most strongly related to wanting a checklist used and feeling less like production pressure impedes patient safety.

Discussion

Using a novel instrument, we measured organizational readiness, team climate, safe practice adherence, and perceived overall safety of practice in 38 hospitals in South Carolina that were embarking on a statewide collaborative initiative to implement a customized version of the World Health Organization's Surgical Safety Checklist. While mostly positive, our results indicate that, at baseline, there was wide variation among hospitals and considerable room for improvement. In each dimension measured, a substantial proportion of responses were negative or neutral, particularly with regard to current levels of safe practice. In addition, 15% of surgical team members overall and up to 57% in individual hospitals indicated they would not feel safe being treated in their own operating room. More than half of the personnel overall (up to 100% in an individual hospital) reported that production pressure hinders safety, whereas almost all personnel indicated a preference for the use of surgical checklists.

The persistent negative and neutral responses among hospitals suggest most hospitals could benefit from innovations that promote safe surgical practice. The substantial rates of personnel in many hospitals who reported not feeling safe if they were a patient and the even higher rates reporting unsafe production pressure are particularly disturbing. However, strong performance of some hospitals on many items, factors, and dimensions suggests some are more prepared for innovations such as surgical safety checklists, while others may require significant support and encouragement. Variation among hospitals also implies that strong teamwork and safe practice are possible, and that many facilities might benefit from collaborations that provide opportunities for cross-institutional learning.

Our results highlight differences in attitudes and perceptions among professional disciplines. A key finding was that physicians were more positive overall about surgical safety and especially regarding interpersonal factors, including quality of clinical leadership and levels respect. Given physicians' critical role in achieving these aspects of teamwork, hospitals are unlikely to make significant progress without physicians' recognition of differing views among other personnel. Likewise, surgeons were far less likely than others to report experiencing production pressure hindering patient safety. Since they are usually not responsible for transitions between cases, and may not even be present for them, it is unsurprising that surgeons do not experience pressure as acutely as other personnel, including anesthesiologists. In addition, unlike other team members, surgeons can slow their work pace if they feel patient safety is at risk. Similar to prior literature (Makary et al., 2006; Singer et al., 2009; Sullivan et al., 2007; Thomas, Sexton, & Helmreich, 2003), these results imply that status and authority differences among surgeons, other physicians, and nonphysicians may cause physicians, especially surgeons, to feel more positive about their work environment.

However, in the context of an intervention that seeks to minimize these differences, these baseline results provide powerful evidence implementation leaders can use to motivate physicians' involvement.

Our results also support the reliability and validity of our survey instrument. Psychometric results support the integrity of a five-factor interpersonal dimension, including communication, coordination, leadership, respect, and assertiveness. Strong relationships between measures of readiness, teamwork, and adherence to safe practice with perceived consequences of safe practice also provide preliminary criterion validity for the survey by reinforcing the need for these factors.

Implications

Our intent was to provide rapid, actionable feedback for implementation leaders to use to motivate, direct, and assess implementation efforts at the outset of a statewide collaborative effort to implement surgical checklists. In doing so, we address the need for validated, detailed measures of teamwork to guide best practice identified by a recent systematic review of the impact of surgical safety checklists on the quality of teamwork and communication in the operating room (Russ et al., 2013). In Appendix B, we illustrate how survey results can be translated into opportunities for change. For example, if the survey finds that surgical team members do not feel comfortable speaking up in the operating room, implementation leaders can emphasize how surgical checklists can be used to invite every team member to voice concerns. Anecdotal reports from implementation leaders suggest that many were successful in using the data this way. In particular, low levels of readiness prompted several implementation leaders to conduct outreach through education forums and one-on-one conversations to persuade staff of the benefits of using checklists in surgery. Data that are derived from one's own organization, tailored to the innovation, and benchmarked against peer institutions reinforces the rationale for the innovation and equips leaders to overcome oft-heard objections such as, "We don't need to do this," or "We already do this well." Additionally, the ability to quantify the gap in perceptions between surgeons and other personnel can promote acceptance of the need for change among this powerful constituency. An innovation like the Surgical Safety Checklist may then be introduced as a means for closing the gap. The ability to measure contextual, interpersonal, practical, and consequential dimensions closely aligned with a patient safety innovation in surgery thus represents a powerful tool for innovation implementation leaders.

Anecdotal information suggests that timely, innovation-specific survey data can motivate hospitals to implement the Surgical Safety Checklist. One senior service administrator from a hospital told an investigator,

> The thing that was particularly helpful—kind of a wake-up call that we have a ways to go—was the safety culture study. … Even though we had a surgical safety checklist out there, the process we've gone through in collaboration with you guys has caused us to revisit that.

Limitations

Results should be viewed in the context of study limitations. First, while all 67 hospitals in South Carolina that perform surgery agreed to participate in an initiative to implement the Surgical Safety Checklist and despite substantial recruitment efforts, not all hospitals agreed to conduct and share survey results. Thus, we cannot rule out the possibility of selection bias. Second, South Carolina hospitals may not be representative of hospitals elsewhere. Using our instrument in a more diverse set of hospitals would test the generalizability of our framework, instrument, and results. Third, our survey omitted factors that could affect the effectiveness of innovation implementation (Damschroder et al., 2009), such as competing demands, staffing levels, team composition, and senior manager support. We obtained these instead through archival data or a questionnaire directed at implementation leaders in each hospital. Fourth, even though our response rates were comparable with those in other voluntary surveys of surgical personnel (Flin, Burns, Mearns, Yule, & Robertson, 2006; Gore et al., 2009), the potential for bias due to response patterns remains. As reported above, we found hospitals with higher response rates also had higher survey scores on average, suggesting that response rate itself may be a safety indicator. Variable response rates may have underestimated observed differences among hospitals. However, relationships identified between teamwork variables and consequences of safe practice were robust to sensitivity analysis that included survey return date as a control using the subset of data for which survey return dates were available (i.e., electronic surveys). We also cannot rule out the possibility that characteristics we did not measure could distinguish among hospitals or professional disciplines. Fifth, the observed relationship between the consequential dimensions and other survey constructs is subject to common method bias. We included these results because we believe them to be significant, and we controlled for all available characteristics of respondents and for hospital response rate. However, as we could identify no marker variable that would have allowed us to adjust more fully for the effect of bias (Podsakoff, MacKenzie, & Lee, 2003), results should be considered preliminary.

A final limitation of this study is that our findings represent an initial assessment of participating hospitals, before implementation occurred. Validation of our hypothesis—that improvement in teamwork and safe practice will be associated with effective implementation of the Surgical Safety Checklist—will require follow-up data and a comparison with implementation effectiveness.

Conclusion

We sought to evaluate a novel survey and describe the status of factors likely to influence or be influenced by effective checklist implementation. Our approach reflects a belief that measures that are tailored for patient safety innovations can help motivate and inform implementation efforts by providing baseline data that identify comparative strengths and weaknesses. Our results portray contextual, interpersonal, practical, and consequential dimensions of surgical practice in South Carolina hospitals. Findings

suggest that current practice warrants patient safety innovations like surgical safety checklists and that strategies for improving implementation effectiveness might especially benefit from efforts to engage surgeons. Future research will investigate the ability of effective checklist implementation to improve teamwork, adherence to recommended safety practices, and perceived consequences of safe practice and correlations of hospital performance on this survey with measures of successful implementation or patient outcomes.

Appendix A

Appendix A-1. Factor Analysis.

Item number and question	Hypothetical factor	Factor loadings				Comments
		Factor 1-2	Factor 3	Factor 4	Factor 5	
Q18. Plans for patient care are adapted as needed.	Coordination	0.64	—	—	—	1
Q13. Surgical team members share key information as it becomes available.	Communication	0.64	—	—	—	
Q16. Surgeons and anesthesia providers work together as a well-coordinated team.	Coordination	0.64	—	—	—	
Q15. Physicians and nurses work together as a well-coordinated team.	Coordination	0.61	—	—	—	
Q17. Surgical team members from different disciplines always discuss patients' conditions and the progress of operations.	Coordination	0.61	—	—	—	2, 3
Q12. Surgical team members make sure their comments or instructions are heard.	Communication	0.56	—	—	—	
Q14. Surgical team members appear eager to help one another.	Coordination	0.56	—	—	—	4
Q21. Decision making is shared among disciplines in response to changes in patients' conditions or issues that arise during operations.	Leadership	0.45	—	—	—	5
Q10. Team discussions (e.g., briefings or debriefings) are common.	Communication	0.43	—	—	—	
Q6. I am encouraged to report any patient safety concerns I may have.	Assertiveness	0.4	—	—	—	6
Q24. Surgical team members communicate with me in a respectful manner.	Respect	—	0.82	—	—	
Q26. I am always treated as a valuable member of the surgical team.	Respect	—	0.8	—	—	
Q25. My input about patient care is well received by other surgical team members.	Respect	—	0.8	—	—	
Q27. Potential errors or mistakes are pointed out without raised voices or condescending remarks.	Respect	—	0.45	—	—	7

(continued)

Appendix A (continued)

Item number and question	Hypothetical factor	Factor loadings				Comments
		Factor 1-2	Factor 3	Factor 4	Factor 5	
Q9r. It is difficult to speak up when I perceive problems with patient care.	Assertiveness	—	—	0.65	—	
Q7r. It is difficult to discuss medical mistakes.	Assertiveness	—	—	0.61	—	
Q8r. Surgical team members appear to struggle and do not ask one another for help.	Assertiveness	—	—	0.59	—	8
Q22. Physicians are present and actively participating in patient care prior to skin incision.	Leadership	—	—	—	0.58	9
Q23. Physicians maintain a positive tone throughout operations.	Leadership	—	—	—	0.54	10
Q19r. Physicians are only open to suggestions from other physicians.	Leadership	—	—	—	0.32	11, 12
Q20. Disagreements are resolved with an emphasis not on who is right but what is right for the patient.	Leadership	—	—	—	—	13, 14
Q11r. Communication breakdowns frequently lead to delays in starting surgical procedures.	Communication	—	—	—	—	15

Note. Factor loading values of ≤0.30 have been excluded from the table. The stem "In the ORs where I work" has been removed for brevity for all questions listed.
r. Item was reverse coded.
[1]An early version of the survey did not include this item.
[2]Retained temporarily, however, may be preferable to reword or drop item in future as current wording blurs boundaries between communication and coordination factors.
[3]An early version of the survey did not include this item.
[4]An early version of the survey used slightly different wording: "Surgical team members readily offer to help one another."
[5]Dropped because emphasis on shared decision making blurred boundary between leadership and coordination/communication factors.
[6]Dropped due to need for rewording; to load with assertiveness factor as intended better wording may be "I report any patient safety concern I may have." Alternatively, to emphasize requirement that staff feel psychologically safe in order to be assertive, preferred revision might be, "I feel safe speaking up if I perceive there may be a problem."
[7]An early version of the survey used slightly different wording: "Errors or mistakes are pointed out without raised voices or condescending remarks."
[8]An early version of the survey used slightly different wording: "Surgical team members ask one another for help."
[9]An early version of the survey did not include this item.
[10]An early version of the survey used slightly different wording: "Physician leaders (i.e., surgeons and anesthesiologists) set a positive tone for team interactions."
[11]Retained for theoretical reasons; openness to suggestions from others is an important aspect of clinical leadership not covered by other items. To reflect intended meaning for leadership factor, better wording may be "Physicians are open to suggestions from all members of the surgical team." Loading is greater than 0.30 and Cronbach's alpha remains above 0.7 when item is included (α = 0.72 with Q19 included and α = 0.74 with Q19 omitted).
[12]An early version of the survey used slightly different wording: "Physician leaders (i.e., surgeons and anesthesiologists) are open to suggestions from all team members."
[13]Dropped due to low loading on all factors and because emphasis on disagreements blurred boundary between leadership and coordination/communication factors.
[14]An early version of the survey used slightly different wording: "Disagreements are resolved appropriately (i.e., with an emphasis not on who is right but what is right for the patient)."
[15]Dropped due to low loading on any factor and need for rewording; to load with communication factor as intended, better wording may be "Miscommunication occurs frequently due to surgical procedures."

Appendix A-2. Descriptive Statistics for Dimensions and Factors.

	Derivation sample (n = 926)			Validation sample (n = 926)			Combined sample (N = 1,852)							
							Factor correlations (alpha on the diagonal)							
Dimension/factor	*M*	*SD*	α	*M*	*SD*	α	F1	F2	F3	F4	F5	D2	D3	D4
D1. Interpersonal (teamwork)	5.23	1.11		5.23	1.08									
F1: Communications	5.06	1.34	0.79	5.06	1.28	0.78	0.78							
F2: Coordination	5.28	1.20	0.88	5.28	1.22	0.89	0.76	0.88						
F3: Respect	5.33	1.33	0.92	5.36	1.35	0.91	0.63	0.74	0.92					
F4: Assertiveness	5.53	1.31	0.73	5.47	1.35	0.78	0.54	0.57	0.52	0.75				
F5: Clinical Leadership	4.90	1.38	0.72	4.84	1.38	0.71	0.55	0.65	0.69	0.47	0.71			
D2. Contextual (readiness)	5.53	1.00	0.64	5.50	1.02	0.66	0.57	0.60	0.53	0.53	0.52	0.65		
D3. Practical (adherence)	4.79	1.25	0.72	4.75	1.24	0.74	0.66	0.66	0.57	0.46	0.56	0.49	0.73	
D4. Consequential	5.47	1.03		5.44	1.01		0.47	0.54	0.58	0.44	0.52	0.53	0.45	0.31

Appendix B

Examples of How Surgical Safety Culture Survey Results May Be Used to Motivate and Direct Intervention Efforts: Interpretation of Results and Corresponding Opportunity by Dimension, Factor, or Item.

Dimension/factor or item	Interpretation of results	Corresponding opportunity
Contextual dimension		
Readiness	When we implement the checklist, we might run into the same difficulties we had when we attempted to put previous innovations into place.	We may need to educate surgical teams about the benefits of using checklists in the OR before commencing implementation.
Interpersonal dimension		
Assertiveness	We want everyone to feel like they can speak up and discuss mistakes in our ORs. Survey results suggest we have more work to do to make everyone feel this way.	The checklist invites every member of the surgical team to speak and voice any concerns about the patient prior to skin incision. Research suggests this will also promote speaking up during the case.
Communication	Some people who work in our ORs feel that communication among surgical team members could be improved. We do not share information, listen to each other, or use briefings as well as we might.	Team communication can be improved with the checklist. Checklist use provides a structure for communication in the OR and encourages every member of the surgical team to speak up.
Coordination	Members of our surgical teams do not feel that we work together well in the OR.	Using the checklist can help us work better together as a team by having the team share an operative plan, discuss equipment needs, or anything else that might be needed for the patient.
Clinical Leadership	Physicians should set a positive tone in the OR. Members of the surgical team should share leadership and decision making with their colleagues based on the needs of the patient. By these measures, our physicians are not always seen as good leaders.	Using the checklist can help promote shared leadership. By calling on each member of the surgical team to provide information, the checklist helps team members recognize each team member's unique expertise.
Respect	We want every member of the surgical team to feel respected by his or her fellow team members. Survey results suggest not everyone feels valued in this way.	The checklist invites every member of the surgical team to speak. It also encourages team members to refer to each other by name rather than role. This highlights each team member's unique expertise and their value, as individuals, to the surgical team.
Practical dimension		
Adherence with safe surgical practice	Survey results show that we do not routinely perform all of the essential elements included on the checklist. We still have work to do to ensure that all of the elements are performed for every patient every time.	The checklist may be used as a teaching tool as well as a real-time reminder of all the elements that should be performed with each case.
	Survey results show that we do not consistently address equipment issues and other problems raised in postoperative briefings.	The checklist encourages surgical team members to raise issues in postoperative debriefings that have the potential to improve surgical care in the future. In order for the checklist to have the most benefit, all hospitals should put a system into place to fix the issues that are raised during the checklist debriefing.

(continued)

Appendix B (continued)

Dimension/factor or item	Interpretation of results	Corresponding opportunity
Consequential dimension		
Q33. Would staff feel safe being treated here as a patient?	Our goal is for all staff to feel safe if they needed to be taken care of as patients in our facilities. Any number of responses above zero indicates that we still have work to do.	Successful implementation of the checklist should lead to improved surgical safety culture and staff attitudes. An improved safety culture generally makes people feel that the care they provide is safer and that they would be safer as patients themselves.
Q34. Would we want the checklist to be used if we were having an operation?	Typically, people say they would prefer that the checklist were used if they were having an operation themselves.	When you encounter resistance to the hard work of implementing the Surgical Safety Checklist, reminding surgical staff that most of their colleagues say they would want the checklist to be used if they were having an operation can be helpful.
Q35. Does pressure to move quickly from case to case hinder patient safety?	While it is obvious that time pressure causes stress and makes people feel unsafe, it is important to understand the degree to which this is felt in our own ORs.	Addressing problems identified through postoperative briefings as recommended by the checklist has the potential to improve OR work flow.

Note. OR = operating room.

Acknowledgments

We gratefully acknowledge the contribution to this research of organizational and implementation leaders and staff members from participating South Carolina hospitals, The South Carolina Hospital Association, The Safe Surgery 2015 Leadership Council, the Safe Surgery Team at Ariadne Labs, Stuart Lipsitz at Ariadne Labs, Alan Zaslavsky at Harvard Medical School, and the research assistance provided by Julia Kite and Juliana Stone at the Harvard T.H. Chan School of Public Health.

Declaration of Conflicting Interests

Dr. Gawande has received royalties from multiple publishers for his books and essays on improving health care, including through use of checklists. The remaining author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This work was supported by a grant from AHRQ (R18:HS019631). The Safe Surgery 2015 initiative is supported by a grant from the Branta Foundation.

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