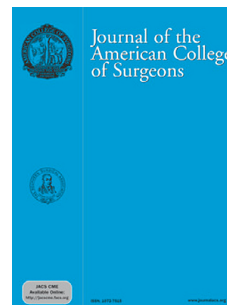


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Implementation of the Surgical Safety Checklist in South Carolina Hospitals Is Associated with Improvement in Perceived Perioperative Safety

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BRIEF TITLE: Improvement in Perceived Perioperative Safety

Structured Abstract

BACKGROUND: Prior research suggests surgical safety checklists (SSCs) are associated with reductions in postoperative morbidity and mortality as well as improvement in teamwork and communication. These findings stem from evaluations of individual or small groups of hospitals. Studies with more hospitals have assessed the relationship of checklists with teamwork at a single point in time. The objective of this study was to evaluate the impact of a large-scale implementation of SSCs on staff perceptions of perioperative safety in the operating room.

STUDY DESIGN: As part of the Safe Surgery 2015 initiative to implement SSCs in South Carolina hospitals, we administered a validated survey designed to measure perception of multiple dimensions of perioperative safety among clinical operating room personnel before and after implementation of an SSC.

RESULTS: Thirteen hospitals administered baseline and follow-up surveys, separated by one to two years. Response rates were 48.4% at baseline (929/1921) and 42.7% (815/1909) at follow-up. Results suggest improvement in five of the five dimensions of teamwork (relative percent improvement ranged from +2.9% for coordination to +11.9% for communication). These were significant after adjusting for respondent characteristics, hospital fixed-effects, and multiple comparisons, and clustering robust standard errors by hospital (all $p < 0.05$). More than half of respondents (54.1%) said their surgical teams always used checklists effectively; 73.6% said checklists had averted problems or complications.

CONCLUSIONS: A large-scale initiative to implement SSCs is associated with improved staff perceptions of mutual respect, clinical leadership, assertiveness on behalf of safety, team coordination and communication, safe practice, and perceived checklist outcomes.

Introduction

The World Health Organization (WHO) Surgical Safety Checklist (SSC) is a simple and scalable innovation aimed at improving the safety of surgical care. The original study evaluating the implementation of the WHO SSC demonstrated that its use was associated with significant reductions in postoperative morbidity and mortality in diverse hospital settings.¹ Multiple subsequent studies have also found reductions in either postoperative complications²⁻⁵ and/or postoperative mortality^{6,7} after implementation of a SSC. Additionally, studies have demonstrated that perceptions of safety at a hospital level are associated with outcomes.⁸⁻¹⁰ However, not all studies support the former findings; Urbach and colleagues reported no change in postoperative outcomes in Ontario, Canada after evaluating the impact of regionally mandated implementation of a SSC.¹¹

These discrepant findings suggest that the way hospitals implement SSCs is key to their ability to effect clinically significant changes. Some explanations offered by one of the commentators for why investigators observed no change in postoperative outcomes in Ontario include that the provincial government mandated the SSC, that hospitals' implementation initiatives were ineffective, and that the majority of reported hospitals did not modify the SSC to meet their specific needs.¹² In order for a SSC to reduce postoperative complications and mortality, prior research suggests that hospitals need to intentionally implement the checklist using a structured approach, most often, led by implementation leaders who persuasively convey the rationale and effectively demonstrate methods for using it.¹³

As part of the Safe Surgery 2015 initiative to implement SSCs in South Carolina, we sought to

measure how a statewide implementation of a SSC affects OR personnel perceptions of the safety of surgery by administering a validated survey before and after implementing the SSC. To our knowledge this is the first study to evaluate the impact of a statewide initiative to implement a SSC at multiple hospitals with pre- and post-implementation analysis.

Methods

Sample

The Safe Surgery 2015: South Carolina initiative is a statewide collaborative designed to promote implementation of SSCs in South Carolina hospitals. The initiative targeted all 67 hospitals performing surgery in South Carolina. As part of the initiative, we invited participating hospitals to administer surveys before and following their active participation in the implementation program. The SSC implementation program included a live webinar series and support in the form of educational training materials and tools to evaluate ongoing SSC implementation. Hospitals were invited to perform a follow-up survey when they indicated that their SSC implementation program was complete. On average, the follow-up survey was administered one to two years after the baseline survey. As described elsewhere,¹⁴ 38 hospitals administered baseline surveys; 13 of these hospitals felt that they had completed the SSC implementation program and also administered follow-up surveys. There were no statistically significant differences in baseline perceptions of perioperative safety between the 13 hospitals that completed baseline and follow-up surveys and the 25 hospitals that only completed the baseline survey. This study only included the 13 hospitals that completed the baseline and follow-up surveys.

At each hospital, the target sample was 100% of clinical OR personnel, including surgeons, anesthesiologists, certified registered nurse anesthetists (CRNAs), surgical nurses, and surgical technicians. In order to keep participation anonymous we did not collect information that would enable matching pre- and post-test responses for individual respondents.

Survey Instruments

The development and validation of the survey instrument, which drew from the Agency for Healthcare Research and Quality's (AHRQ) Hospital Survey of Patient Safety Culture (HSOPS), the Patient Safety Climate in Healthcare Organizations Survey, the Operating Room Brief Assessment Tool (ORBAT), and the Safety Climate Sub-Scale from the Safety Attitudes Questionnaire, has been described elsewhere.¹⁴ The survey instrument used in this study, however, differed from its predecessors in that it was a survey created specifically for healthcare personnel working in the operating room environment.

Surveys administered in the initial and follow-up periods differed slightly. Both surveys included items representing the five teamwork factors we defined as respect, clinical leadership, assertiveness, coordination, and communication, which collectively comprised an interpersonal dimension. The initial and follow-up surveys also included the following factors: supportive context and adherence to safe practice (constituting a practical dimension), and impact of safe practice, e.g., "I would feel safe being treated here as a patient" (forming a consequential dimension). However, because the initial survey was intended to determine how well prepared surgical teams were for checklist implementation, the pre-test version of the survey also measured readiness (a contextual dimension; data not presented here). In contrast, the post-test

version of the survey sought to assess how well implementation had gone after hospitals had completed their active participation in the Safe Surgery South Carolina implementation program (approximately one year after the baseline survey). The post-test version of the survey thus omitted the readiness items and instead added measures of implementation process and implementation effectiveness. The post-test survey also added to the consequential dimension items assessing the perceived impact of checklist use.

For both pre- and post-intervention surveys, we developed two versions, a “long” version that included all items and a “short” version, which was abridged based on preliminary psychometric analysis to encourage response among surgeons, anesthesiologists, physician assistants and CRNAs (collectively called “physicians and advanced practice clinicians”). The long and short versions of the pre-intervention survey included 35 and 12 items, respectively. The long and short versions of the post-intervention survey included 31 and 15 items, respectively. All survey items offered a 7-point Likert response scale except for the new item assessing checklist impact by asking whether problems or complications have been averted by the checklist, which offered a yes/no choice.

Both instruments included a demographic characteristics section, capturing information about age, gender, race, and ethnicity of respondents. All questions were multiple-choice, and a “decline to answer” choice was provided for gender, race, and ethnicity. Respondents were also asked to provide information about their occupation and how long they had held that role in any hospital. The long versions of the pre- and post-intervention surveys are included as Appendix 2 (Figures 1 and 2, online only), respectively. The long-version of both the pre- and post-surveys

contain all questions, including questions in the short-version of the survey administered to physicians and advanced practice clinicians.

Survey Administration Procedures

A site manager from each participating hospital provided the project team with a list of clinical personnel who work in the hospital's ORs, their occupations, and, when available, their e-mail addresses. Surveys were administered in print and/or online, at the discretion of the hospital. There were no differences in content between the two formats.

For print administration, survey distribution and collection were the responsibility of the site managers, who returned completed surveys to the project team. Six hospitals in the pre-test and one hospital in the post-test opted to administer their surveys online. Two hospitals used a hybrid approach where they administered the surveys in print and online. Online administration included an initial personalized email followed by at least two reminders sent at eight-day intervals. The final dataset merged print and online sources.

All study procedures were developed in collaboration with the South Carolina Hospital Association and approved by the human subject committees of participating institutions.

Data Analysis

Participants were excluded if they answered less than 50% of survey items. We compared demographic characteristics of respondents in the initial and follow-up surveys using Chi-square tests. Similar to a method previously reported,¹⁴ we categorized the seven-point Likert scale

responses into strongly positive (7), positive (5-6), and neutral/negative (1-4), given the rightward skew of the responses. Grouping neutral and negative responses together recognized that neutral responses may imply a weak climate.¹⁵ All negatively worded items were reversed scored. When aggregating responses to calculate factor and dimension scores, we followed an analysis previously published,¹⁴ which included calculating unweighted averages across items to summarize factors and across the five teamwork factors to create a summary interpersonal dimension (overall teamwork) score. We classified aggregated scores <4.5 as negative/neutral, 4.5 to 6.5 as positive, and >6.5 as strongly positive.

We initially compared differences in item scores in the initial and follow-up periods (unadjusted analysis) using Chi-square tests. This included items that appeared on both the long and short survey versions. We also evaluated separately the full set of items administered to non-physicians only and then items administered to physicians and advanced practice clinicians only. Although we present neutral/negative, agree, and strong agree responses, we compared neutral/negative to agree combined with strongly agree when reporting whether the change in the post-implementation survey compared to the pre-implementation survey was statistically significant. It is important to note that 4 items were only administered in the post-surveys and therefore were not amenable to statistical testing to assess if there were significant changes in the post compared to the pre-implementation period. Next, we compared factor and interpersonal dimension scores between the initial and follow-up periods. For two teamwork factors (respect and clinical leadership) in which all items appeared on both physician/advanced practice clinicians and surgical nurses/technicians, we calculated a summary score by averaging physician/advanced practice clinicians and surgical nurses/technicians. For the other factors and

the interpersonal dimension, the items included on each survey differed. Thus, we averaged the physician/advanced practice clinicians' responses to the short version of the survey and similarly averaged the surgical nurses/technicians responses to the long version of the survey. We then calculated a weighted average score using the percent of physicians/advanced practice clinicians and surgical nurses/technicians that responded to the survey. To facilitate interpretation, we calculated the unadjusted relative percent change between the pre- and post-test average scores of the five factors and overall teamwork dimension using items that appeared on surveys administered to all OR personnel. To test the significance of these differences between pre- and post-test scores, we used generalized linear regression models for all five factors and the overall teamwork dimension as outcomes. To account for potential differences by respondent type and hospital, we adjusted for all respondent characteristics and clustered robust standard errors by hospital using the clustered standard sandwich estimator.

We explored the relationship between teamwork and surgical outcomes by comparing hospital-level teamwork factor scores and perceived impact of safe practice as measured by physician/advanced practice clinicians and surgical nurses/technicians response to a single item: "I would feel safe being treated here as a patient." We then compared perceived checklist implementation effectiveness ("The entire surgical team always stops at 3 critical points") and perceived impact of checklist use ("In ORs where I work, potential problems or complications have been averted by the use of the checklist," and "Using the checklist helps my cases run more smoothly") among the 13 hospitals and then among the different provider roles.

All p-values less than 0.05 were considered statistically significant. Due to the multiple

comparisons, we calculated p-values using a correction method designed to limit the false discovery rate (expected rate of type I error).¹⁶ This is a conservative approach given the relatively high correlation among factors comprising the teamwork dimension. Statistical analyses were conducted using SAS 9.3.

Results

Overall response rate for the 13 hospitals that completed both initial and follow-up surveys after excluding respondents that answered less than 50% of the survey items (84 and 26 respondents in the initial and follow-up surveys were excluded, respectively) was 48.4% at baseline (929/1921) and 42.7% (815/1909) at follow-up. Distribution of survey respondents' roles differed in the follow-up survey compared to the initial survey ($p=0.0017$), but whether respondents were physicians/advanced practice clinicians did not ($p=0.25$) (Table 1). Differences in distribution of respondents' tenure in their respective roles ($p=0.11$), gender ($p=0.09$), age ($p=0.09$), race ($p=0.94$) and Hispanic/Latino ethnicity ($p=0.81$) were non-significant.

Table 2 compares the distribution of responses to statements relating to all but the readiness items included in the initial and follow-up surveys administered to all OR personnel. In the follow-up survey, 49.0% of OR personnel strongly agreed that they would feel safe as a patient in their ORs compared to 41.7% in the initial survey. There were statistically significant improvements in responses to more than half of all items (6 out of 11 items). The largest improvements in participants' responses (follow-up compared to initial survey considering percent of agree/strongly agree responses) after implementation of the SSC pertained to the

following statements: “Team discussions (e.g., briefings or debriefings) are common” (Q10, 15.0% improvement, 71.4% of participants responded with agree or strongly agree at follow-up compared to 56.4% initially, $p < 0.0001$); “Physicians are open to suggestions” (Q18, 9.0% improvement, 70.3% versus 61.3%, $p < 0.0001$); and “Potential errors or mistakes are pointed out without raised voices or condescending remarks” (Q24, 6.8% improvement, 70.2% versus 63.4%, $p = 0.0002$). Overall, more than half of respondents (54.1%) reported that their surgical teams always used checklists effectively, and approximately 73.6% reported that checklists had averted problems or complications.

As can be seen by comparing Appendix 1 (Table 1, online only) to Table 2, physician/advance practice clinician responses improved more than others. Responses among physicians and advanced practice clinicians improved significantly for 9 out of 11 items while responses among all OR personnel improved in 6 (Appendix 1, Table 1). Among surgical nurses/technicians only (Appendix 1, Table 2), responses for most items showed improvement; however, changes were often smaller and less frequently statistically significant (8 out of 24 items). A notable exception was the communication items: surgical nurse/technician responses for all four of these items in the long survey improved significantly. In contrast, for the 11 items that were administered in the long and short versions of the surveys both pre and post, only 2 of these items showed statistically significant improvements among the surgical nurses/technicians cohort compared to 9 items among the advanced practice clinicians group.

In the unadjusted analysis, relative percent improvement in all five interpersonal dimension factors ranged from +2.9% for coordination to +11.9% for communication (Table 3). The

improvement in the average overall teamwork (interpersonal dimension) score was +5.4%. In the adjusted analysis, improvement in the overall teamwork score was statistically significant (regression coefficient=0.291, standard error=0.049, $p<0.001$). Likewise, improvements in all five teamwork factors were statistically significant, with coefficients ranging from 0.160 for coordination to 0.624 for communication (p -values ranging from <0.05 to <0.001).

For our sample of 13 hospitals, the Pearson correlation coefficient (r) between hospital-level teamwork scores and OR personnel feeling safe as a patient in their hospitals was 0.55 ($p=0.05$) (Figure 1). Hospital-level analysis suggested that OR personnel's perceptions of implementation effectiveness were significantly related to improvement in perceived impact of checklist use. Specifically, there was a statistically significant correlation between whether OR personnel agreed/strongly agreed with the item "The entire surgical team always stops at 3 critical points," and "In ORs where I work, potential problems or complications have been averted by the use of the checklist" ($r=0.63$, $p=0.02$), and similarly between the former and the item "Using the checklist helps my cases run more smoothly" ($r=0.79$, $p=0.0013$) (Figure 2).

Figure 3 compares perceptions of implementation effectiveness and two perceived impacts of checklist use by professional discipline. Surgeons were more likely to agree/strongly agree that the entire surgical team always stopped at all three critical points during the procedure to read the checklist compared to nurses (65% versus 41%, $p<0.0001$) and compared to anesthesiologists and CRNAs combined (65% versus 49%, $p=0.0018$). The majority of OR personnel agreed/strongly agreed that using the checklist helped their cases run more smoothly, but the differences between surgeons and nurses ($p=0.48$) and surgeons and anesthesiologists/CRNAs

($p=0.83$) were non-significant. Although nurses were the least likely to agree/strongly agree that the SSC was used appropriately, they along with surgical technicians were most likely to agree/strongly agree that problems or complications had been averted by the checklist – there was a statistically significant difference between nurses (75%) and surgeons (65%) ($p=0.04$). The difference between surgeons and anesthesiologists/CRNAs in whether problems or complications were averted by the checklist was non-significant ($p=0.12$).

Discussion

Implementation of a SSC in 13 South Carolina hospitals is associated with improvements in OR personnel's perception of mutual respect, effective leadership, ability to be assertive when necessary to improve safety, coordination among surgeons and anesthesia providers, and effective communication. Additionally, there was improvement in whether OR personnel would feel safe being treated as patients at their respective hospitals after implementation of the SSC. Nevertheless, even after implementation of an SSC only about half of respondents (49%) strongly agreed that they would feel safe being treated at their respective hospitals. This clearly suggests the need for more work to improve perioperative safety. However, it may also reflect increased awareness among those implementing an SSC of existing deficits in the culture of surgical safety in their work environment. Such improved awareness may have negatively affected how participants responded to this item. This finding also indicates that despite the SSC being an important tool for improving the culture of surgical safety, it was not a fix-all solution. The work necessary to improve the culture of surgical safety requires long-term efforts that include multiple interventions targeting the diverse aspects of interaction between healthcare providers providing surgical care at a hospital.

Findings from this study suggest that implementation of the SSC affected healthcare professionals differently depending on their role. Physicians and advanced practice clinicians responded more favorably than surgical nurses/technicians in the post-implementation survey when compared to the pre-implementation survey. Of the 11 items that were administered to all OR personnel and that permitted evaluation for change after implementation of the SSC, surgical nurses/technicians perceived considerably fewer improvements than physicians and advanced practice clinicians. Furthermore, we found a notable discrepancy between how well surgeons and other OR personnel felt the SSC was performed. Surgeons reported a higher completion rate at all three critical stopping points in the SSC compared to other OR personnel. Yet, they less frequently reported that using the SSC helped promote efficiency and avert problems or complications in the OR compared to nurses and surgical technicians. Nurses less often reported always stopping at all three critical points, but were among the most likely to agree/strongly agree that the SSC had improved efficiency and safety. Consistent with findings from our previous work that identified that surgeons responded more positively than non-surgeons to questions assessing perceptions of safe surgical practice,¹⁴ these findings indicate different vantages, perceptions, and/or expectations. Whichever the source, the need for more perspective sharing across disciplines is clear.

Effectively implementing a SSC (which we defined in this study as implementing a SSC such that all operating room (OR) personnel always stop at all three critical points during the procedure to read the checklist: before induction of anesthesia, before skin incision, and before the patient leaves the OR) and using a SSC in a way that improves teamwork (which we have

suggested includes clinical leadership, communication, coordination, assertiveness, and respect¹⁴) is paramount to realizing potential improvements in operative outcomes. Our findings expand on previously published research^{10, 17-29} included in a systematic review³⁰ and meta-analysis³¹ that showed a positive effect of using a SSC on the perioperative culture of safety, teamwork, and communication, by including the largest sample of hospitals (N=13) with pre- and post-implementation survey data in the context of a statewide initiative to promote SSC implementation. Most of the studies included in this systematic review drew on single (N=17), two (N=1), or a small number of hospitals (N=2). Additionally, we address an important weakness found in previous research,³⁰ which is the evaluation of the relationship between how well a SSC was used (based on responses to the statement, “The entire surgical team always stops at 3 critical points”) and its effect on OR personnel’s perception of averting problems or complications and helping cases run more smoothly.

The Veterans Health Administration (VHA) Medical Team Training study, which was not included in Russ and colleagues’ review and consisted of medical team training, briefings and debriefings, involved a larger sample of hospitals and also reported reductions in postoperative complications³² and mortality³³ and improvement in teamwork, efficiency, and perceptions of safety.³⁴ The latter study³⁴, however, is based on final interviews and does not include a baseline assessment.

There are many barriers to implementing SSCs outside of controlled study environments, and these barriers could explain why only 13 out of 38 hospitals felt that they had completed the SSC implementation program and were ready for the follow-up survey. Fourcade and colleagues

identified that two of the most commonly observed barriers to effective implementation of a mandated SSC in 18 centers in France included duplication of existing processes and poor communication between physicians.³⁵ Another study found that the most commonly reported barrier was active resistance or passive noncompliance among senior surgeons and/or anesthesiologists.³⁶

Limitations

Our study has certain limitations. First, we were unable to measure change in perceptions of safety among specific individuals over time. Organizers of the program believed that offering respondents anonymity was essential for promoting honest replies to the survey and preventing individuals from fearing repercussions from superiors or colleagues. Second, we have not linked our staff perceptions of change associated with checklist implementation with patient-level outcomes at the 13 hospitals in this study. Nevertheless, we hypothesize that improvements observed in the perception of perioperative safety in this study have likely led to improvements in clinical outcomes based on a previous study³⁷ that showed an association between overall surgical teamwork scores and outcomes. Third, we were not able to account for non-response bias. Fourth, this study only included inpatient hospitals located in South Carolina. Further research is needed to assess whether these findings are generalizable more broadly. Finally, there may be differences between the hospitals that administered post-implementation surveys and hospitals that did not. Of particular concern is that hospitals that did not administer a post-implementation survey may have achieved less improvement than the hospitals that participated, in which case our results would be overstated. Two things mitigate this concern. First, baseline perception of perioperative safety for hospitals that completed both surveys did not differ in any

systematic way from hospital that only completed the initial survey without completing the follow-up survey. Second, change between follow-up and initial surveys for the 13 hospitals included in this study varied, and several hospitals experienced deterioration in teamwork measures, suggesting that hospitals participating in the follow up survey were not necessarily all star performers.

Another limitation is that only 54.1% of respondents reported using the checklist effectively and this bring into question whether the changes in perception of perioperative surgical safety were truly derived through SSC implementation. However, a recent study, in which only 62.1% of all OR cases effectively used the SSC, found a significant reduction in the risk of postoperative complications when all three components of the SSC were completed.³⁸ Consistent with these findings, our study suggests that effective use of the SCC in only a portion of ORs may be associated with positive changes at a hospital level.

Conclusion

A statewide implementation of a SSC was associated with improvements in the perception of teamwork and perceived perioperative safety among OR personnel. This study used pre- and post-implementation data from 13 hospitals in South Carolina, which to our knowledge is the largest study of its kind. Further research should evaluate how improvements in teamwork and communication among surgical teams that stems from using SSCs relate to reductions in postoperative morbidity and mortality.

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Table 1. Respondent Characteristics

	Initial, n (%)	Follow-up, n (%)	p Value*
n	929	815	
Role			0.0017
Surgeon	198 (21.3)	170 (21)	
Anesthesiologist	42 (4.5)	63 (7.7)	
CRNA	169 (18.2)	143 (17.6)	
Surgical nurse	267 (28.7)	222 (27.2)	
Surgical tech	161 (17.3)	158 (19.4)	
Other	81 (8.7)	38 (4.7)	
Missing	11 (1.2)	21 (2.6)	
Physicians and advanced practice clinicians [†]			0.25
Yes	409 (44.6)	376 (46.1)	
No	509 (55.4)	418 (51.3)	
Missing	11 (1.2)	21 (2.6)	
Years in role			0.11
<1	63 (6.86)	38 (4.7)	
1–5	208 (22.66)	182 (22.3)	
6–10	149 (16.23)	151 (18.5)	
>10	498 (54.25)	397 (48.7)	
Missing	11 (1.2)	47 (5.8)	
Sex			0.09
Male	314 (33.8)	280 (34.36)	
Female	574 (61.79)	481 (59.02)	
Declined [‡]	25 (2.69)	37 (4.54)	
Missing	16 (1.7)	17 (2.09)	
Age, y			0.09
18–25	35 (3.8)	23 (2.8)	
26–35	162 (17.4)	153 (18.8)	
36–45	245 (26.4)	222 (27.2)	
46–55	277 (29.8)	203 (24.9)	
>55	172 (18.5)	151 (18.5)	
Declined [‡]	28 (3.0)	40 (4.9)	
Missing	10 (1.1)	23 (2.8)	
Race			0.94
Asian	15 (1.6)	11 (1.4)	
Black	68 (7.3)	47 (5.8)	
White	742 (79.9)	554 (68)	
Other race [§]	12 (1.3)	11 (1.4)	
Declined [‡]	77 (8.3)	125 (15.3)	
Missing	15 (1.6)	67 (8.2)	
Ethnicity			0.81
Hispanic/Latino	12 (1.3)	10 (1.2)	
Non Hispanic	844 (90.9)	634 (77.8)	

Declined [‡]	53 (5.7)	95 (11.7)	
Missing	20 (2.2)	76 (9.3)	

*Chi-squared test was used to test differences among groups. Declined and missing data were excluded from this test in order to reduce bias.

[†]Physicians and advanced practice clinicians included surgeons, anesthesiologists, CRNAs and physician assistants.

[‡]These include respondents who declined to provide an answer to the demographic question.

[§]This includes respondents who identified belonging to a race that was not listed or as being multiracial.

Table 2. Item-Level Analysis of the Perception of Surgical Safety among all Operating Room Personnel before and after Checklist**Intervention**

Dimension*/factor/item	Initial, %			Follow-up, %			p Value [†]
	Neutral/negative	Agree	Strongly agree	Neutral/negative	Agree	Strongly agree	
Implementation process							
Q1. I was given a strong explanation for why it is important to use the checklist.	--	--	--	15.2	37.08	47.70	
Interpersonal (teamwork)							
Respect							
Q21. Surgical team members communicate with me in a respectful manner.	22.14	50.76	27.11	18.34	50.43	31.23	0.06
Q22. My input about patient care is well received by other surgical team members.	19.35	51.78	28.86	15.26	50.50	34.24	0.016
Q23. I am always treated as a valuable member of the surgical team.	24.78	44.37	30.84	20.54	45.17	34.28	0.08
Q24. Potential errors or mistakes are pointed out without raised voices or condescending remarks.	36.89	47.49	15.86	29.85	47.26	22.89	0.0002
Clinical leadership							
Q18. Physicians are open to suggestions. [‡]	38.71	43.49	17.80	29.68	46.38	23.94	<0.0001
Q19. Physicians are present and actively participating in patient care prior to skin incision.	38.13	36.11	25.76	39.85	34.99	25.16	0.78
Q20. Physicians maintain a positive tone throughout operations.	38.76	47.88	13.36	36.32	46.27	17.41	0.06
Assertiveness							
Q6. I feel safe speaking up if I perceive there may be a problem. [§]	12.21	34.35	53.44	8.72	31.57	59.70	0.01
Coordination							
Q16. Surgeons and anesthesia providers work together as a well-coordinated team.	21.19	51.68	27.14	19.30	48.50	32.20	0.065
Communication							
Q10. Team discussions (eg briefings or debriefings) are common.	43.59	36.30	20.11	29.64	41.72	29.64	<0.0001
Practical							
Implementation effectiveness							
Q5. In the ORs where I work, the entire surgical				45.88	33.50	20.63	

team always stops at all 3 critical points: --during the procedure to read the checklist (before induction of anesthesia, --before skin incision, and --before the patient leaves the room).	--	--	--				
Consequential							
Impact of safe practice							
Q30. I would feel safe being treated here as a patient.	14.72	43.62	41.66	13.34	37.66	49.00	0.009
Impact of checklist use							
Q3. In the ORs where I work, using the checklist helps my cases run more smoothly.	--	--	--	28.38	41.25	30.38	
Q31. In the ORs where I work, problems or complications have been averted by the checklist.	--	--	--		26.40	73.60 [¶]	

All operating room personnel included surgeons, anesthesiologists, CRNAs, physician assistants, surgical nurses, and surgical techs. Comparison of response for additional items administered only to surgical nurses and surgical techs is available in the online Appendix, Table 1.

*The practical (adherence with checklist intent) dimension does not appear in this table because all practical items were included only in the surgical nurses and surgical technicians (long-version of the) survey.

[†]Chi-square test comparing the distribution of agree/strongly agree responses in the initial vs follow-up surveys.

[‡]Wording for some items was revised from the initial to the follow-up survey. The question for the initial survey read: "Physicians are only open to suggestions from other physicians," and was reverse-scored.

[§]"I am encouraged to report any patient safety concerns I may have."

^{||}No.

[¶]Yes.

Table 3. Perceptions of Teamwork among All Operating Room Personnel before and after Checklist Intervention

	Dimension	Factors				
	Interpersonal (overall teamwork)	Respect	Leadership	Assertiveness	Coordination	Communication
No. of respondents	1,579	1,586	1,584	1,586	1,586	1,584
Unadjusted analysis						
Mean initial score	5.23	5.33	4.85	5.63	5.49	4.87
Mean follow-up score	5.51	5.52	5.02	5.95	5.65	5.45
Relative change, %	5.4	3.6	3.5	5.7	2.9	11.9
Adjusted analysis* coefficient (standard error)						
Follow-up compared to initial survey	0.291 (0.049)	0.178 (0.055)	0.205 (0.105)	0.309 (0.073)	0.160 (0.05)	0.624 (0.056)
p Value [†]	<0.001	<0.05	<0.05	<0.05	<0.05	<0.001

*To account for potential differences by respondent type and hospital, adjusted models accounted for all respondent characteristics, including primary role, gender, age, ethnicity, and race, and clustered robust standard errors by hospital.

[†]p Values are corrected for multiple comparisons using the Benjamini-Liu step-down false discovery correction method.

FIGURE LEGENDS

Figure 1. Change in surgical team member perceptions overall (average of all domains) and feeling of safety by hospital (Pearson Correlation Coefficient = 0.55, $p=0.05$).

Figure 2. Surgical team member perceptions of the impact of checklist use by hospital. (A) Potential problems have been averted by the use of the checklist. (B) Using the checklist helps my cases run more smoothly.

Figure 3. Surgical team member perceptions of checklist implementation effectiveness and impact of checklist use by provider role.

Precis

Surgical safety checklist implementation has been associated with improvement in morbidity, mortality, and perceptions of teamwork and communication in small cohorts of hospitals. We show that a statewide initiative to implement surgical safety checklists in South Carolina hospitals was associated with improved perception of perioperative safety.

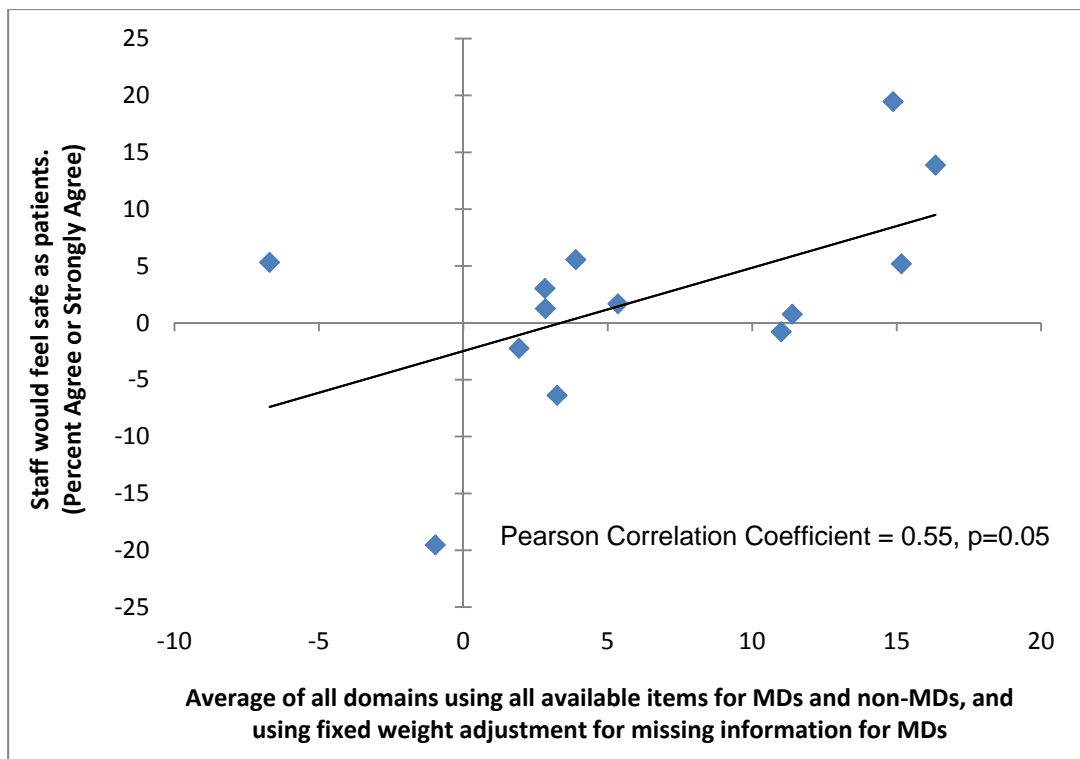


Figure 1.

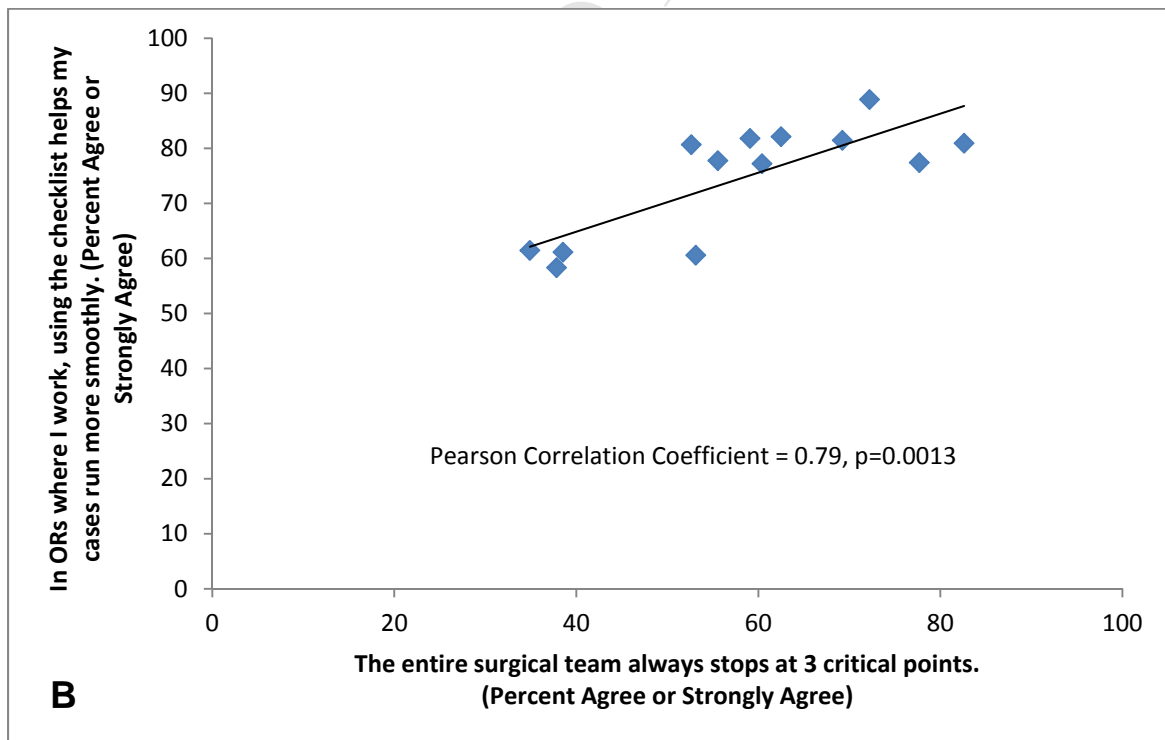
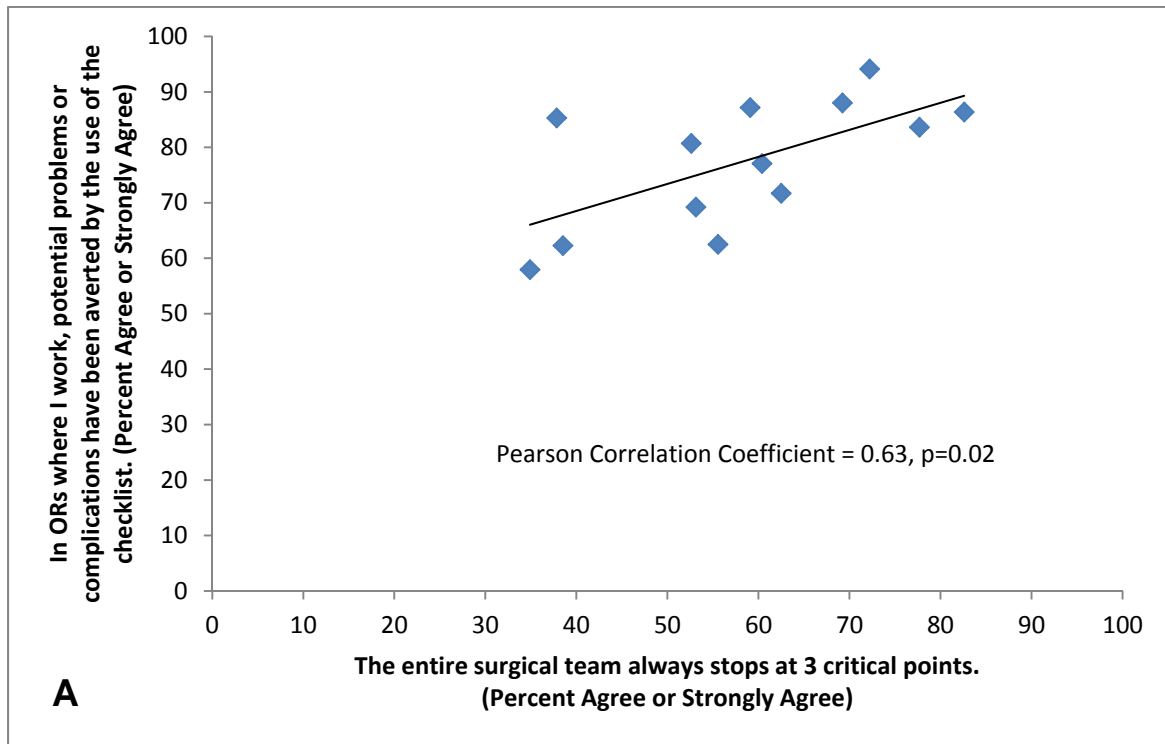


Figure 2.

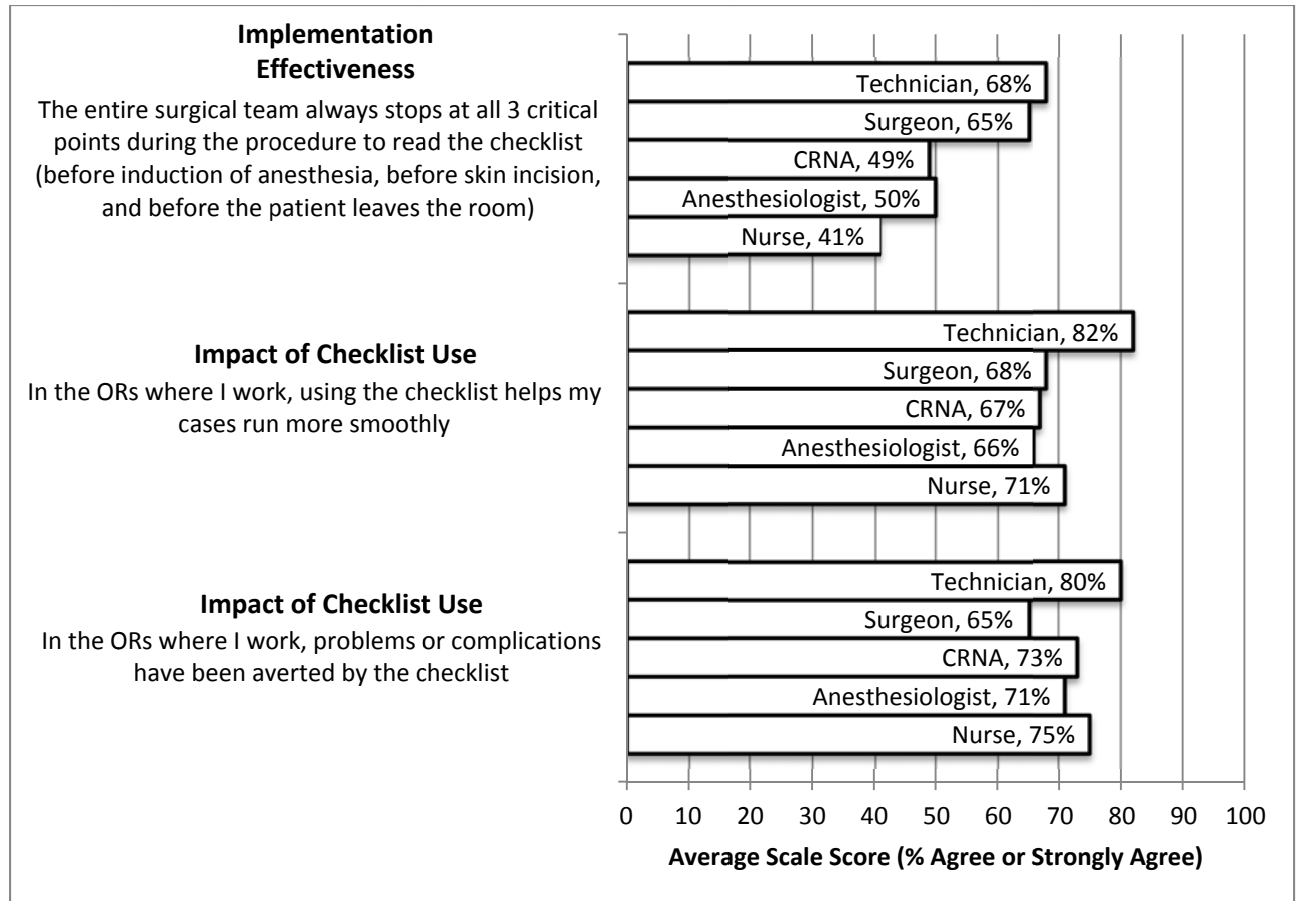


Figure 3.

Appendix 1

Table 1. Item-Level Analysis of the Perception of Surgical Safety among Physicians and Advanced Practice Clinicians before and after Checklist Intervention

Dimension*/factor/item	Initial, %			Follow-up, %			p Value [†]
	Neutral/negative	Agree	Strongly agree	Neutral/negative	Agree	Strongly agree	
Implementation process							
Q1. I was given a strong explanation for why it is important to use the checklist.	--	--	--	17.96	38.61	43.43	
Interpersonal (teamwork)							
Respect							
Q21. Surgical team members communicate with me in a respectful manner.	13.45	50.86	35.7	13.14	43.43	43.43	0.07
Q22. My input about patient care is well received by other surgical team members.	12.71	49.88	37.41	10.22	40.32	49.46	0.003
Q23. I am always treated as a valuable member of the surgical team.	16.22	43.24	40.54	15.01	35.12	49.87	0.027
Q24. Potential errors or mistakes are pointed out without raised voices or condescending remarks.	28.43	51.23	20.34	19.19	47.03	33.78	<0.0001
Clinical leadership							
Q18. Physicians are open to suggestions. [‡]	29.5	46	24.5	19.24	45.26	35.5	0.0003
Q19. Physicians are present and actively participating in patient care prior to skin incision.	26.87	37.95	35.18	29.57	36.02	34.41	0.709
Q20. Physicians maintain a positive tone throughout operations.	28.19	53.43	18.38	25	48.92	26.08	0.034
Assertiveness							
Q6. I feel safe speaking up if I perceive there may be a problem. [§]	13.76	38.33	47.91	6.93	22.93	70.13	<0.0001
Coordination							
Q16. Surgeons and anesthesia providers work together as a well-coordinated team.	17.2	50.86	31.94	14.17	41.71	44.12	0.0021
Communication							
Q10. Team discussions (eg briefings or debriefings) are common.	41.87	38.18	19.95	23.12	39.78	37.1	<0.0001
Practical							

Implementation effectiveness							
Q5. In the ORs where I work, the entire surgical team always stops at all 3 critical points: --during the procedure to read the checklist (before induction of anesthesia, --before skin incision, and --before the patient leaves the room).	--	--	--	43.63	33.60	22.76	
Consequential							
Impact of safe practice							
Q30. I would feel safe being treated here as a patient.	12.5	40.93	46.57	9.41	35.48	55.1	0.04
Impact of checklist use							
Q3. In the ORs where I work, using the checklist helps my cases run more smoothly.	--	--	--	32.52	39.02	28.46	
Q31. In the ORs where I work, problems or complications have been averted by the checklist.	--	--	--		30.7	69.3 [¶]	

Physicians and advanced practice clinicians included surgeons, anesthesiologists, CRNAs, and physician assistants.

*The practical (adherence with checklist intent) dimension does not appear in this table because all practical items were included only in the surgical nurses and surgical technicians (long-version of the) survey.

[†]Chi-square test comparing the distribution of agree/strongly agree responses in the initial vs follow-up surveys.

[‡]Wording for this item was revised from the initial to the follow-up survey. The question for the initial survey read: "Physicians are only open to suggestions from other physicians," and was reverse-scored.

[§]Wording for this item was revised from the initial to the follow-up survey. The question for the initial survey read: "I am encouraged to report any patient safety concerns I may have."

^{||}No.

[¶]Yes.

Table 2. Perception of Surgical Safety among Surgical Nurses and Surgical Technicians before and after Checklist Intervention

Dimension*/factor/item	Initial, %				Follow-up, %		p Value [†]
	Neutral/negative	Agree	Strongly agree	Neutral/negative	Agree	Strongly agree	
Implementation process							
Q1. I was given a strong explanation for why it is important to use the checklist.	--	--	--	12.84	35.78	51.38	
Q2. The training I received about how to use the checklist allowed me to use it effectively during surgical procedures.	--	--	--	15.44	42.76	41.81	
Interpersonal (teamwork)							
Respect							
Q21. Surgical team members communicate with me in a respectful manner.	29.01	50.68	20.31	22.81	56.45	20.74	0.08
Q22. My input about patient care is well received by other surgical team members.	24.61	53.29	22.09	19.59	59.22	21.20	0.12
Q23. I am always treated as a valuable member of the surgical team.	31.53	45.26	23.21	25.29	53.79	20.92	0.02
Q24. Potential errors or mistakes are pointed out without raised voices or condescending remarks.	43.55	44.12	12.33	38.94	47.47	13.59	0.35
Leadership							
Q18. Physicians are open to suggestions. [‡]	46.09	41.48	12.42	38.57	47.34	14.09	0.06
Q19. Physicians are present and actively participating in patient care prior to skin incision.	47.56	34.57	17.87	48.72	34.11	17.17	0.94
Q20. Physicians maintain a positive tone throughout operations.	47.17	43.47	9.36	46.06	43.98	9.95	0.92
Assertiveness							
Q6. I feel safe speaking up if I perceive there may be a problem. [§]	10.98	31.18	57.84	10.25	38.95	50.81	0.05
Q7. It is difficult to discuss medical mistakes. [§]	33.79	36.91	29.30	33.81	38.06	28.13	0.95
Q8. Surgical team members appear to struggle and do not ask one another for help. [§]	26.61	39.92	33.47	24.82	37.83	37.35	0.47
Q9. It is difficult to speak up when I perceive problems with patient care. [§]	28.82	36.17	35.01	22.35	40.00	37.65	0.07
Coordination							

Q14. Surgical team members appear eager to help one another.	29.77	47.67	22.57	27.93	52.35	19.72	0.34
Q15. Physicians and nurses work together as a well-coordinated team.	26.02	52.04	21.94	24.94	56.94	18.12	0.24
Q16. Surgeons and anesthesia providers work together as a well-coordinated team.	24.32	52.32	23.36	23.69	54.21	22.10	0.83
Q17. Plans for patient care are adapted as needed.	18.62	53.10	28.28	12.06	61.94	26.00	0.009
Communication							
Q10. Team discussions (eg briefings or debriefings) are common.	44.94	34.82	20.23	35.32	43.35	21.33	0.0006
Q11. Miscommunication occurs frequently during surgical procedures. [¶]	59.50	32.56	7.95	24.06	40.80	35.14	<0.0001
Q12. Surgical team members make sure their comments or instructions are heard.	31.97	47.95	20.0%	23.35	55.19	21.46	0.013
Q13. Surgical team members share key information as it becomes available.	30.16	44.75	25.10	20.24	52.71	27.06	0.002
Practical							
Supportive context [#]							
Q29. Equipment issues or other problems discussed in postoperative debriefings are addressed in a timely manner.	43.69	42.28	14.03	38.90	44.63	16.47	0.30
Adherence to safe practice							
Q26. Surgical teams always discuss the operative plan (i.e., more than the location of the incision and name of procedure) before incision.	43.70	36.81	19.49	33.57	48.68	17.75	0.0009
Q27. For complex patients or cases, preoperative briefings always include planning for potential problems.	44.09	39.08	16.83	33.17	50.84	15.99	0.0009
Q28. Postoperative debriefings always include a discussion of key concerns for patient recovery and post-op management.	54.97	33.47	11.56	50.24	39.18	10.58	0.20
Implementation effectiveness							
Q5. In the ORs where I work, the entire surgical team always stops at all 3 critical points:	--	--	--	47.80	33.41	18.79	

--during the procedure to read the checklist (before induction of anesthesia, --before skin incision, and --before the patient leaves the room).							
Consequential							
Impact of safe practice							
Q30. I would feel safe being treated here as a patient.	16.50	45.78	37.72	16.74	39.53	43.72	0.12
Impact of checklist use							
Q3. In the ORs where I work, using the checklist helps my cases run more smoothly.	--	--	--	24.83	43.16	32.02	
Q4. Patient safety has improved as a result of using the checklist.	--	--	--	22.60	44.47	32.92	
Q31. In the ORs where I work, problems or complications have been averted by the checklist.					22.76**	77.24 ^{††}	

*Chi-square statistic comparing the distribution of agree/strongly agree responses in the initial vs follow-up surveys.

[†]Wording for this item was revised from the initial to the follow-up survey. The question for the initial survey read: "Physicians are only open to suggestions from other physicians," and was reverse-scored.

[‡]Wording for this item was revised from the initial to the follow-up survey. The question for the initial survey read: "I am encouraged to report any patient safety concerns I may have."

[§]Item was reverse-scored.

^{||}Item removed due to scaling problems: Q25. Surgical team members refer to each other by role instead of name (eg "Nurse" instead of "Dana").

[¶]Wording for this item was revised from the initial to the follow-up survey. The question for the initial survey read: "Communication breakdowns frequently lead to delays in starting surgical procedures."

[#]Domain name "supportive context" was developed during post-test analysis to better represent item content.

**No.

^{††}Yes.



Our hospital is committed to offering the safest possible surgical care. We are therefore partnering with hospitals statewide, the South Carolina Hospital Association (SCHA) and the Harvard School of Public Health (HSPH) in the *Safe Surgery 2015: South Carolina initiative*. The goal of this program is to measurably reduce surgical infections, major complications, and mortality through effective implementation of a surgical safety checklist. As part of this project, we are conducting a “surgical safety culture” survey. Your response will help us understand surgical team members’ perspectives on patient safety in our operating rooms.

The survey asks you to think about the operating rooms in which you most often work. In completing the survey we would like you to think about your average experience.

- The survey should take **no more than 5 minutes** to complete.
- Your decision to participate is **completely voluntary**, and refusal to participate will not affect your job in any way. You may skip any questions that you do not feel you can answer.
- The questionnaire is **completely anonymous**. Survey responses will be processed by independent researchers affiliated with HSPH. No one at this hospital or the SCHA will have access to individual responses; they will only see summary reports. Individual responses will never be reported in published or unpublished documents that result from this study.
- Your completion of this survey indicates your consent to participate in this study.

If you have questions about your rights as a study participant or if you are dissatisfied with any aspect of the study, please contact the HSPH Office of Human Research Administration at ohra@hsph.harvard.edu, 617-384-5480 or 866-606-0573 (toll-free). For additional information regarding this research, please call Dr. Sara Singer at HSPH at 617-432-7139 or email ssinger@hsph.harvard.edu.

Your response matters to us! Please complete the survey today. Thank you for your participation.

SAFE SURGERY 2015: SOUTH CAROLINA Surgical Safety Culture Survey

A. Are you (or will you be) the person or one of the people responsible for checklist implementation in the ORs where you work?

- ⁰¹ Yes
⁰⁰ No

B. In which surgical service(s) do you work? (Check all that apply.)

- ⁰¹ General
⁰² Trauma
⁰³ Orthopedic
⁰⁴ Neurosurgery
⁰⁵ Cardiac
⁰⁶ Thoracic
⁰⁷ Vascular
⁰⁸ Pediatric
⁰⁹ ENT
¹⁰ Urology
¹¹ Gynecology
¹² Ambulatory
⁹⁹ Other: _____

C. In which service do you work most often? (Check one.)

- ⁹⁸ N/A: No primary service
⁰¹ General
⁰² Trauma
⁰³ Orthopedic
⁰⁴ Neurosurgery
⁰⁵ Cardiac
⁰⁶ Thoracic
⁰⁷ Vascular
⁰⁸ Pediatric
⁰⁹ ENT
¹⁰ Urology
¹¹ Gynecology
¹² Ambulatory
⁹⁹ Other: _____

D. Gender:

- ⁰¹ Male
⁰⁰ Female
⁹⁷ Decline to answer

E. Age:

- ⁰¹ 18-25
⁰² 26-35
⁰³ 36-45
⁰⁴ 46-55
⁰⁵ >55

F. What is your primary professional role?

- ⁰¹ Surgeon
⁰² Anesthesiologist
⁰³ CRNA
⁰⁴ Surgical nurse
⁰⁵ Physician assistant
⁰⁶ Surgical tech
⁰⁷ Perfusionist
⁰⁸ Intern/Resident/Fellow
⁹⁹ Other: _____

G. How many years have you worked in this role (at any hospital)?

- ⁰¹ <1
⁰² 1-5
⁰³ 6-10
⁰⁴ >10

	Strongly Disagree	Strongly Agree
1. In the ORs where I work, surgical team members are open to changes that improve patient safety, even if it means slowing down.	① ② ③ ④ ⑤ ⑥ ⑦	
2. In the ORs where I work, the Joint Commission "Time Out" is used in every case by every surgical team.	① ② ③ ④ ⑤ ⑥ ⑦	
3. In the ORs where I work, the Joint Commission "Time Out" was difficult to implement.	① ② ③ ④ ⑤ ⑥ ⑦	
4. In the ORs where I work, surgical team members all agree on the importance of using checklists in surgery.	① ② ③ ④ ⑤ ⑥ ⑦	
5. In the ORs where I work, interest in checklist implementation is limited to one profession (e.g., surgery, anesthesia, or nursing).	① ② ③ ④ ⑤ ⑥ ⑦	
6. In the ORs where I work, I am encouraged to report any patient safety concerns I may have.	① ② ③ ④ ⑤ ⑥ ⑦	
7. In the ORs where I work, it is difficult to discuss medical mistakes.	① ② ③ ④ ⑤ ⑥ ⑦	
8. In the ORs where I work, surgical team members appear to struggle and do not ask one another for help.	① ② ③ ④ ⑤ ⑥ ⑦	
9. In the ORs where I work, it is difficult to speak up when I perceive problems with patient care.	① ② ③ ④ ⑤ ⑥ ⑦	
10. In the ORs where I work, team discussions (e.g., briefings or debriefings) are common.	① ② ③ ④ ⑤ ⑥ ⑦	
11. In the ORs where I work, communication breakdowns frequently lead to delays in starting surgical procedures.	① ② ③ ④ ⑤ ⑥ ⑦	
12. In the ORs where I work, surgical team members make sure their comments or instructions are heard.	① ② ③ ④ ⑤ ⑥ ⑦	
13. In the ORs where I work, surgical team members share key information as it becomes available.	① ② ③ ④ ⑤ ⑥ ⑦	
14. In the ORs where I work, surgical team members appear eager to help one another.	① ② ③ ④ ⑤ ⑥ ⑦	
15. In the ORs where I work, physicians and nurses work together as a well-coordinated team.	① ② ③ ④ ⑤ ⑥ ⑦	

	Strongly Disagree	Strongly Agree
16. In the ORs where I work, surgeons and anesthesia providers work together as a well-coordinated team.	① ② ③ ④ ⑤ ⑥ ⑦	
17. In the ORs where I work, surgical team members from different disciplines always discuss patients' conditions and the progress of operations.	① ② ③ ④ ⑤ ⑥ ⑦	
18. In the ORs where I work, plans for patient care are adapted as needed.	① ② ③ ④ ⑤ ⑥ ⑦	
19. In the ORs where I work, physicians are only open to suggestions from other physicians.	① ② ③ ④ ⑤ ⑥ ⑦	
20. In the ORs where I work, disagreements are resolved with an emphasis not on who is right but what is right for the patient.	① ② ③ ④ ⑤ ⑥ ⑦	
21. In the ORs where I work, decision-making is shared among disciplines in response to changes in patients' conditions or issues that arise during operations.	① ② ③ ④ ⑤ ⑥ ⑦	
22. In the ORs where I work, physicians are present and actively participating in patient care prior to skin incision.	① ② ③ ④ ⑤ ⑥ ⑦	
23. In the ORs where I work, physicians maintain a positive tone throughout operations.	① ② ③ ④ ⑤ ⑥ ⑦	
24. In the ORs where I work, surgical team members communicate with me in a respectful manner.	① ② ③ ④ ⑤ ⑥ ⑦	
25. In the ORs where I work, my input about patient care is well received by other surgical team members.	① ② ③ ④ ⑤ ⑥ ⑦	
26. In the ORs where I work, I am always treated as a valuable member of the surgical team.	① ② ③ ④ ⑤ ⑥ ⑦	
27. In the ORs where I work, potential errors or mistakes are pointed out without raised voices or condescending remarks.	① ② ③ ④ ⑤ ⑥ ⑦	
28. In the ORs where I work, surgical team members refer to each other by role instead of name (e.g., "Nurse" instead of "Dana").	① ② ③ ④ ⑤ ⑥ ⑦	
29. In the ORs where I work, surgical teams always discuss the operative plan (i.e., more than the location of the incision and name of the procedure) before incision.	① ② ③ ④ ⑤ ⑥ ⑦	
30. In the ORs where I work, for complex patients or cases, preoperative briefings always include planning for potential problems.	① ② ③ ④ ⑤ ⑥ ⑦	
31. In the ORs where I work, postoperative debriefings always include a discussion of key concerns for patient recovery and post-op management.	① ② ③ ④ ⑤ ⑥ ⑦	
32. In the ORs where I work, equipment issues or other problems discussed in postoperative debriefings are addressed in a timely manner.	① ② ③ ④ ⑤ ⑥ ⑦	
33. I would feel safe being treated here as a patient.	① ② ③ ④ ⑤ ⑥ ⑦	
34. If I were having an operation, I would want a surgical safety checklist to be used.	① ② ③ ④ ⑤ ⑥ ⑦	
35. Pressure to move quickly from case to case gets in the way of patient safety.	① ② ③ ④ ⑤ ⑥ ⑦	

This study is funded by the Agency for Healthcare Research and Quality (AHRQ), which requires all research studies to ask the following demographic questions. If you are uncomfortable answering these questions, please select "Decline to answer".

H. Do you consider yourself Hispanic or Latino?

- ⁰¹ Yes
⁰⁰ No
⁹⁷ Decline to answer
⁹⁶ Unknown

I. Which category best describes your race?

- ⁰¹ American Indian or Alaska Native
⁰² Asian
⁰³ Black or African American
⁰⁴ Native Hawaiian or Other Pacific Islander
⁰⁵ White
⁰⁶ Multiracial
⁹⁷ Decline to answer
⁹⁶ Unknown

If you have any comments or feedback regarding this survey, please use the space below and the back of this sheet:



Dear Colleague:

Perioperative Services at _____ is committed to offering the safest possible surgical care. We are therefore partnering with statewide hospitals, the South Carolina Hospital Association (SCHA) and the Harvard School of Public Health (HSPH) in *Safe Surgery 2015: South Carolina*. The goal is to measurably reduce surgical infections, major complications, and mortality through effective implementation of a surgical safety checklist. As part of this project, we are conducting a “surgical safety culture” survey. Your response will help us understand surgical team members’ perspectives on patient safety in our operating rooms. You may remember receiving a similar survey earlier; this follow up survey will enable us to see any changes.

The survey asks you to think about the operating rooms in which you most often work. In completing the survey we would like you to think about your average experience.

- The survey should take **no more than 5 minutes** to complete.
- Your decision to participate is **completely voluntary**, and refusal to participate will not affect your job in any way. You may skip any questions that you do not feel you can answer.
- The questionnaire is **completely anonymous**. Survey responses will be processed by independent researchers affiliated with HSPH. No one at this hospital or the SCHA will have access to individual responses; they will only see summary reports. Individual responses will never be reported in published or unpublished documents that result from this study.
- Your completion of this survey indicates your consent to participate in this study.
- We value your opinion and would really like to hear from you!

If you have questions about your rights as a study participant or if you are dissatisfied with any aspect of the study, please contact the HSPH Office of Human Research Administration at ohra@hsph.harvard.edu, 617-384-5480 or 866-606-0573 (toll-free). For additional information regarding this research, please call Dr. Sara Singer at HSPH at 617-432-7139 or email ssinger@hsph.harvard.edu.

Thank you for your participation.

Sincerely,

[NAME AND TITLE OF SIGNATORY(IES)]

