

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



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BACKGROUND: Previous research suggests that 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 1 to 2 years. Response rates were 48.4% at baseline (929 of 1,921) and 42.7% (815 of 1,909) at follow-up. Results suggest improvement in all of the 5 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, 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. (*J Am Coll Surg* 2016;222:725–736. © 2016 by the American College of Surgeons. Published by Elsevier Inc. All rights reserved.)

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The World Health Organization 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 World Health Organization 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 postoperative complications²⁻⁵ and/or postoperative mortality^{6,7} after implementation of an SSC. Additionally, studies have demonstrated that perceptions of safety at the hospital level are associated with outcomes.⁸⁻¹⁰ However, not all studies support the former findings; Urbach and colleagues¹¹ reported no change in postoperative outcomes in Ontario, Canada, after evaluating the impact of regionally mandated implementation of an SSC.

Abbreviations and Acronyms

CRNA = certified registered nurse anesthetist
OR = operating room
SSC = surgical safety checklist

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 an SSC to reduce postoperative complications and mortality, previous research suggested 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 statewide implementation of an SSC affects operating room (OR) personnel perceptions of the safety of surgery. We administered 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 an 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 after 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 1 to 2 years after the baseline survey. As described elsewhere,¹⁴ 38 hospitals administered baseline surveys; 13 of these hospitals believed 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 completed only the baseline survey. This study included only 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

Development and validation of the survey instrument, which drew from AHRQ's Hospital Survey of Patient Safety Culture, the Patient Safety Climate in Healthcare Organizations Survey, the Operating Room Brief Assessment Tool, 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 health care personnel working in the OR environment.

Surveys administered in the initial and follow-up periods differed slightly. Both surveys included items representing the 5 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, eg, "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 1 year after the baseline survey). The post-test version of the survey therefore 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 2 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, sex, race, and ethnicity of respondents. All questions were multiple choice, and a “decline to answer” choice was provided for sex, 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 [Supplemental Figures 1 and 2](#) (available online), 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 2 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 1 hospital in the post-test opted to administer their surveys online. Two hospitals used a hybrid approach in which they administered the surveys in print and online. Online administration included an initial personalized email followed by at least 2 reminders sent at 8-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 previously reported method,¹⁴ we categorized the 7-point Likert scale responses into strongly positive (7), positive (5 to 6), and neutral/negative (1 to 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 reverse scored. When aggregating responses to calculate factor and dimension scores, we followed a previously published analysis,¹⁴ which included calculating unweighted averages across items to summarize factors and across the 5 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 nonphysicians 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 administered only 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 2 teamwork factors (respect and clinical leadership) in which all items appeared on both physician/advanced practice clinicians and surgical nurses/technicians surveys, 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. Therefore, 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 who responded to the survey. To facilitate interpretation, we calculated the unadjusted relative percent change between the pre- and post-test average scores of the 5 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 5 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

The overall response rate for the 13 hospitals that completed both initial and follow-up surveys, after excluding respondents who 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 of 1,921) and 42.7% (815 of 1,909) at follow-up. Distribution of survey respondents' roles differed in the follow-up survey compared with 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), sex (*p* = 0.09), age (*p* = 0.09), race (*p* = 0.94) and Hispanic/Latino ethnicity (*p* = 0.81) were nonsignificant.

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 with 41.7% in the initial survey. There were statistically significant improvements in responses to more than half of all items (6 of 11 items). The largest improvements in participant responses (follow-up compared with initial survey considering percent of agree/strongly agree responses) after implementation of the SSC pertained to the following statements: "Team discussions (eg briefings or debriefings) are common" (Q10, 15.0% improvement, 71.4% of participants responded with agree or strongly agree at follow-up compared with 56.4% initially, *p* < 0.0001); "Physicians are open to suggestions" (Q18, 9.0% improvement, 70.3% vs 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% vs 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 Supplemental Table 1 (available online) with Supplemental Table 2 (available online), physician/advance practice clinician responses improved more than others. Responses among physicians and advanced practice clinicians improved significantly for 9 of 11 items (Supplemental Table 1; available online); responses among all OR personnel improved in 6 (Table 2). Among surgical nurses/technicians only (Supplemental Table 2), responses for most items showed improvement; however, changes were often smaller and less frequently statistically significant (8 of 24 items). A notable exception was the communication items: surgical nurse/technician responses for all 4 of these items in the long survey improved significantly. 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 with 9 items among the advanced practice clinicians group.

In the unadjusted analysis, relative percent improvement in all 5 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 5 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

Table 1. Respondent Characteristics

Characteristic	Initial		Follow-up		p Value*
	n	%	n	%	
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-square 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. CRNA, certified registered nurse anesthetist.

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 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.	—	—	—	45.88	33.50	20.63	

(Continued)

Table 2. Continued

Dimension*/factor/item	Initial, %		Follow-up, %		p Value†
	Neutral/negative	Strongly agree	Neutral/negative	Strongly agree	
Consequential					
Impact of safe practice					
Q30. I would feel safe being treated here as a patient.	14.72	43.62	13.34	37.66	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 OR personnel included surgeons, anesthesiologists, CRNAs, physician assistants, surgical nurses, and surgical technicians. Comparison of response for additional items administered only to surgical nurses and surgical technicians is available in [Supplemental Table 1](#) (available online).

*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 proportion 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.

CRNA, certified registered nurse anesthetist; OR, operating room.

OR personnel feeling safe as a patient in their hospitals was 0.55 ($p = 0.05$) (Fig. 1). Hospital-level analysis suggested that OR personnel 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 entire surgical stops at 3 critical points and the item, “Using the checklist helps my cases run more smoothly” ($r = 0.79$, $p = 0.0013$) (Fig. 2).

Figure 3 compares perceptions of implementation effectiveness and 2 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 3 critical points during the procedure to read the checklist compared with nurses (65% vs 41%, $p < 0.0001$) and compared with anesthesiologists and CRNAs combined (65% vs 49%, $p = 0.0018$). The majority of OR personnel agreed/strongly agreed that using the checklist helped their cases run more smoothly, and the differences between surgeons and nurses ($p = 0.48$) and surgeons and anesthesiologists/CRNAs ($p = 0.83$) were nonsignificant. 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 nonsignificant ($p = 0.12$).

DISCUSSION

Implementation of an SSC in 13 South Carolina hospitals is associated with improvements in OR personnel perceptions 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

Table 3. Perceptions of Teamwork among All Operating Room Personnel Before and After Checklist Intervention

Variable	Dimension	Factors				
	Interpersonal (overall teamwork)	Respect	Leadership	Assertiveness	Coordination	Communication
Respondents, n	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 with 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, sex, 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.

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 health care providers providing surgical care at a hospital.

Findings from this study suggest that implementation of the SSC affected health care 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 with the pre-implementation survey. Of the 11 items that were administered to all OR personnel and that permitted evaluation for change after

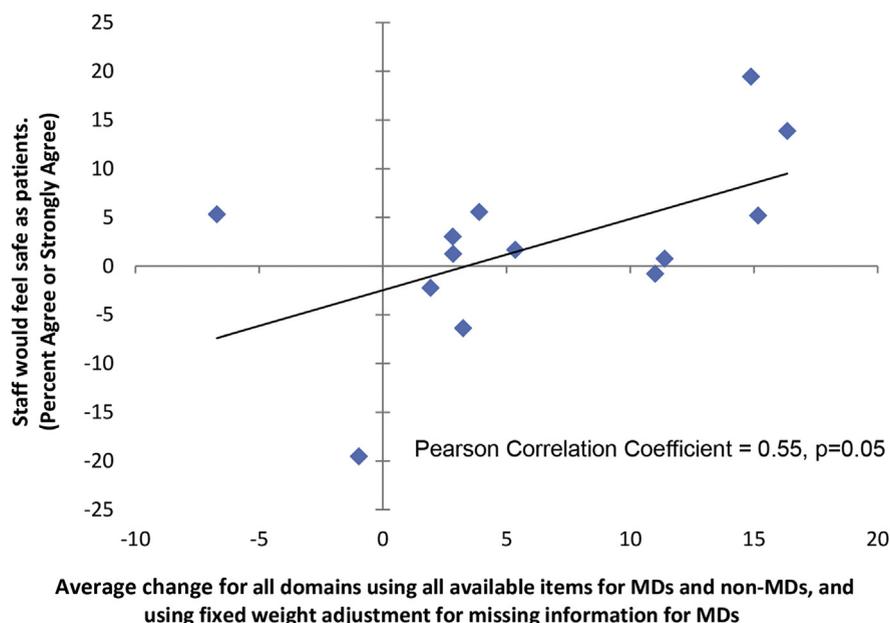


Figure 1. Change in surgical team member perceptions overall (average of all domains) and staff feeling safe by hospital (Pearson Correlation Coefficient = 0.55, $p = 0.05$).

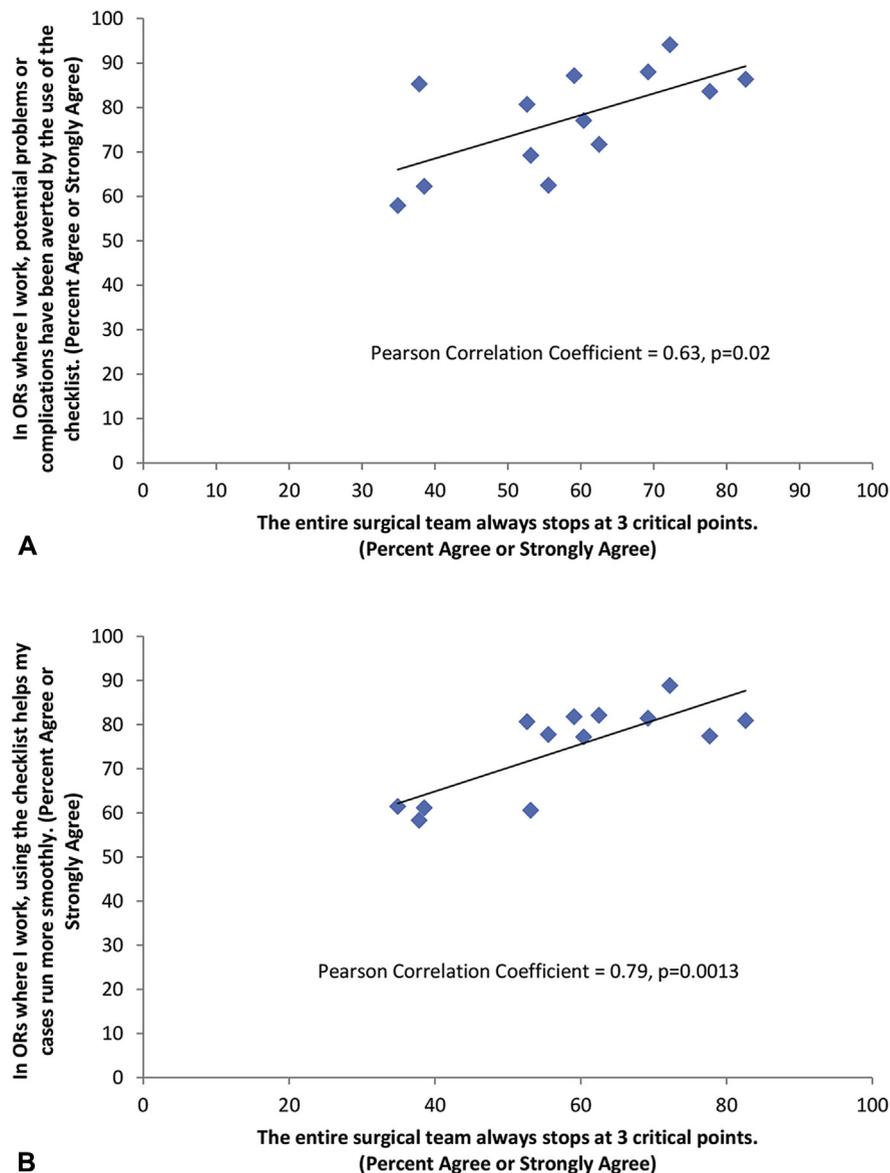


Figure 2. Correlation of perceived implementation effectiveness (whether entire surgical team stops at 3 critical points) and surgical team member perceptions of the impact of checklist use by hospital. (A) Potential problems have been averted by the use of the checklist. (B) Using the checklist helps my cases run more smoothly. OR, operating room.

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 believed the SSC was performed. Surgeons reported a higher completion rate at all 3 critical stopping points in the SSC compared with other OR personnel. Yet, they reported that using the SSC helped promote efficiency and avert problems or complications in the OR less frequently than nurses and surgical

technicians. Nurses less often reported always stopping at all 3 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 nonsurgeons 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.

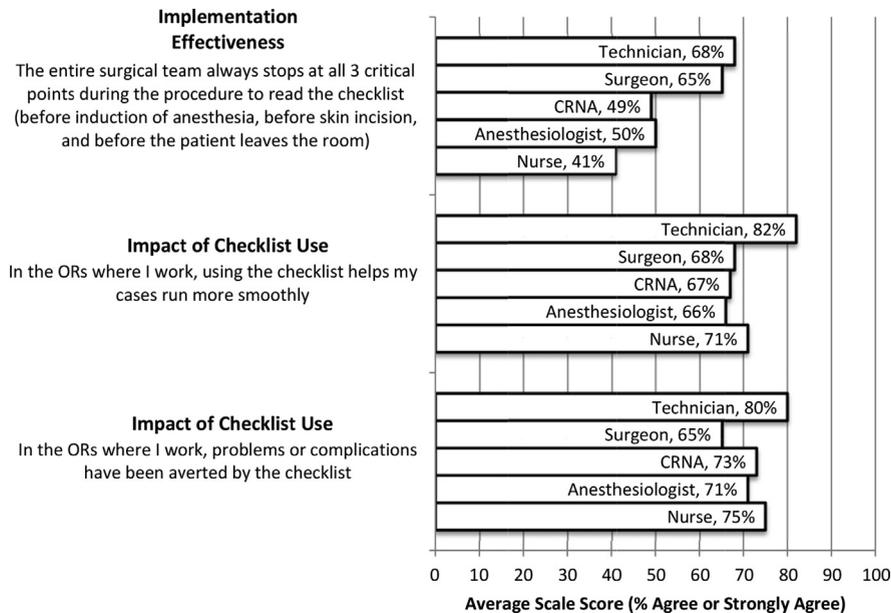


Figure 3. Surgical team member perceptions of checklist implementation effectiveness and impact of checklist use by provider role. CRNA, certified registered nurse anesthetist; OR, operating room.

Effectively implementing an SSC (which we defined in this study as implementing an SSC such that all OR personnel always stop 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 OR) and using an 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-analysis,³¹ which showed a positive effect of using an 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 ($n = 17$), 2 ($n = 1$), or a small number of hospitals ($n = 2$). Additionally, we addressed an important weakness found in previous research³⁰: evaluation of the relationship between how well an 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 Medical Team Training study, which was not included in Russ and

colleagues³⁰ review and consisted of medical team training, briefings and debriefings, involved a larger sample of hospitals, and also reported reductions in postoperative complications³² and mortality,³³ and improvement in teamwork, efficiency, and perceptions of safety.³⁴ The latter study,³⁴ 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 of 38 hospitals believed they had completed the SSC implementation program and were ready for the follow-up survey. Fourcade and colleagues³⁵ determined that 2 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. 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 anonymity to respondents 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 hypothesized 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 nonresponse bias. Fourth, this study included only 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 hospitals that completed only 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 brings 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 3 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.

CONCLUSIONS

Statewide implementation of an 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, and is, to our knowledge, 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.

Author Contributions

Study conception and design: Edmondson, Gibbons, Gawande, Berry, Singer
 Acquisition of data: Edmondson, Gibbons, Haynes, Berry, Singer
 Analysis and interpretation of data: Molina, Jiang, Edmondson, Huang, Kiang, Haynes, Berry, Singer
 Drafting of manuscript: Molina, Jiang, Singer
 Critical revision: Molina, Jiang, Edmondson, Gibbons, Huang, Kiang, Haynes, Gawande, Berry, Singer

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Supplemental 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 proportion 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.

Supplemental 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

(Continued)

Supplemental Table 2. Continued

Dimension*/factor/item	Initial, %			Follow-up, %			p Value [†]
	Neutral/ negative	Agree	Strongly agree	Neutral/ negative	Agree	Strongly agree	
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 during the procedure to read the checklist: –before induction of anesthesia, –before skin incision, and –before the patient leaves the room.	–	–	–	47.80	33.41	18.79	
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 proportion 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 questionnaires are 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.

Your completion of this survey indicates your consent to participate in this study.

- 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.
The questionnaire is completely anonymous.

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 ohr@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?
B. In which surgical service(s) do you work?
C. In which service do you work most often?
D. Gender:
E. Age:
F. What is your primary professional role?
G. How many years have you worked in this role?

Table with 15 rows of survey questions and Likert scale responses (Strongly Disagree to Strongly Agree).

Table with 16 rows of survey questions and Likert scale responses (Strongly Disagree to Strongly Agree).

Demographic questions: H. Do you consider yourself Hispanic or Latino? I. Which category best describes your race?

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

Supplemental Figure 1. Baseline safety of surgery practice survey instrument that was administered to individuals before their hospitals participated in the Safe Surgery 2015: South Carolina surgical safety checklist implementation program.



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.

- Your 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@hsp.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 singer@hsp.harvard.edu.

Thank you for your participation.

Sincerely,

[NAME AND TITLE OF SIGNATORY(IES)]

SAFE SURGERY 2015: SOUTH CAROLINA

Surgical Safety Culture Follow-up Survey

A. Gender:

- Female
Male
Decline to answer

B. Age:

- 18-25
26-35
36-45
46-55
>55
Decline to answer

C. What is your primary professional role?

- Surgeon
Anesthesiologist
CRNA
Surgical nurse
Other:
Physician assistant
Surgical tech
Perfusionist
Intern/Resident/Fellow

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

- <1
1-5
6-10
>10

Table with 2 columns: Statement, and two Likert scales (Strongly Disagree to Strongly Agree). Contains 22 statements regarding surgical safety culture.

Table with 2 columns: Statement, and two Likert scales (Strongly Disagree to Strongly Agree). Contains statements 23-30.

31. In the ORs where I work, problems or complications have been averted by the checklist. Yes No

If problems or complications have been averted, please use the space below or the back of the page to elaborate.

Blank lines for elaboration on question 31.

Any other comments:

Blank lines for other comments.

This project is funded by the Agency for Healthcare Research and Quality (AHRQ), which requires all research studies to ask the following demographic questions. If you prefer not to answer either of these questions, please select "Decline to answer".

- E. Do you consider yourself Hispanic or Latino? F. Which category best describes your race?
Yes/No/Decline to answer/Unknown
American Indian or Alaska Native/Asian/Black or African American/Native Hawaiian or Other Pacific Islander/White/Multiracial/Decline to answer/Unknown

Large blank area for additional survey responses or comments.

Supplemental Figure 2. Follow-up safety of surgery practice survey instrument that was administered to individuals after their hospitals participated in the Safe Surgery 2015: South Carolina surgical safety checklist implementation program. Results were aggregated to the hospital level.