

Original Articles

The Effect of the Perioperative Blood Transfusion and Blood Conservation in Cardiac Surgery Clinical Practice Guidelines of the Society of Thoracic Surgeons and the Society of Cardiovascular Anesthesiologists upon Clinical Practices

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Abstract: The 2007 Society of Thoracic Surgeons and the Society of Cardiovascular Anesthesiologists Clinical Practice Guideline for Perioperative Blood Transfusion and Blood Conservation in Cardiac Surgery was recently promulgated and has received much attention. Using a survey of cardiac anesthesiologists and perfusionists' clinical practice, we assessed the current practices of perfusion, anesthesia, and surgery, as recommended by the Guidelines and also determined the role the Guidelines had in changing these practices. Nontrainee members of the Society of Cardiovascular Anesthesiologists, the American Academy of Cardiovascular Perfusion, the Canadian Society of Clinical Perfusion, and the American Society of ExtraCorporeal Technology were surveyed using a standardized survey instrument that examined clinical practices and responses to the Guidelines. One thousand four hundred and two surveys from 1,061 institutions principally in the United States (677 institutions) and Canada (34 institutions) were returned, with a 32% response rate. There was wide distribution of the Guidelines with 78% of

anesthesiologists and 67% of perfusionists reporting having read all, part, or a summary of the Guidelines. However, only 20% of respondents reported that an institutional discussion had taken place as a result of the Guidelines, and only 14% of respondents reported that an institutional monitoring group had been formed. There was wide variability in current preoperative testing, perfusion, surgical, and pharmacological practices reported by respondents. Twenty-six percent of respondents reported one or more practice changes in response to the Guidelines. The changes made were reported to be highly (9%) or somewhat effective (31%) in reducing overall transfusion rates. Only four of 38 Guideline recommendations were reported by more than 5% of respondents to have been changed in response to the Guidelines. Wide variation in clinical practices of cardiac surgery was reported. Little change in clinical practices was attributed to the Society of Thoracic Surgeons/Society of Cardiovascular Anesthesiologists Guidelines. **Keywords:** transfusion, heart surgery, Guidelines, cardiopulmonary bypass, Factor VIIa. JECT. 2010;42:114–121

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The Society of Thoracic Surgeons (STS) and the Society of Cardiovascular Anesthesiologists (SCA) Clinical Practice Guideline for Perioperative Blood Transfusion and Blood Conservation in Cardiac Surgery was published in 2007 (1) and has received much attention at both societies.

A second iteration of the Perioperative Blood Transfusion and Blood Conservation Guidelines is currently in preparation. Such documents are thought to be a useful and important adjunct to the peer-reviewed literature, because they synthesize the evidence base supporting the management and treatment of cardiac surgical patients (2).

Well-developed guidelines, based on a high level of evidence, have the potential to enhance the appropriateness of clinical practice, improve the quality of care, lead to better patient outcomes, improve cost effectiveness, and identify areas of further research needs (3). Despite the resource-intensive publication of evidence-based guidelines, their adoption into clinical practice is often suboptimal (4). The effectiveness and implementation of guidelines is variable and depends upon how the guidelines are perceived by professional organizations, peer leaders, and individual practitioners (5–9). Without further interventions to encourage implementation, the effectiveness of guidelines is reduced over time (10).

Because blood loss and transfusion-related events confer a substantial burden of cost, morbidity, and mortality to patients undergoing cardiac surgery (11,12), we assessed the current clinical practices of perfusion, anesthesia, and surgery, as recommended by the Guidelines, by using a multisociety survey of clinical practice. We also sought to determine the impact of the Guidelines in changing these practices. We hypothesized that the Guidelines would have made significant changes in these clinical practices. As additional objectives, we examined the current practice in the use of recombinant activated Factor VII (rFVIIa) and leukoreduced blood products, because of the rapid increase in their use in cardiac surgery, and whether studies of the impact of aprotinin withdrawal had been conducted.

METHODS

We developed a qualitative survey of clinical practice (Supplemental Digital Content, Appendix 1). Questions in the survey were based on the recommendations of the Perioperative Blood Transfusion and Blood Conservation in Cardiac Surgery Clinical Practice Guideline, available at http://ats.ctsnetjournals.org/cgi/content/abstract/83/5_Supplement/S27. There were 57 recommendations in the Guidelines. For level of evidence, 13 were level A, 27 were level B, and 17 were level C. For class of recommendation, seven were class I, 18 were class IIa, 23 were class IIb, and 10 were class 3. We attempted to craft questions for all 57 recommendations; however, for 19 recommendations we were unable to create suitable language that survived trials on the test group or were suitable for questioning, because of the ambiguous construction of the recommendation.

Additional questions regarding rFVIIa use and aprotinin withdrawal were included because of recent changes in clinical practice. The questionnaire was pretested to assess face and content validity, comprehensibility, time to completion, and ambiguity. The questionnaire was initially pilot-tested by 14 anesthesiologists and perfusionists who were either members of the Guidelines Taskforce or had leadership positions in their Societies. Several modifications were made based on their feedback. Subsequently, the revised questionnaire was pilot tested on eight individuals before being finalized (Supplemental Digital Content, Appendix 1). The responses from pilot testing were not included in analyses.

Study Cohort and Survey Distribution

E-mail addresses for nontrainee society members were provided by the SCA ($n = 4,140$; <http://www.scahq.org/>), the American Academy of Cardiovascular Perfusion ($n = 367$; <http://theaacp.addr.com/>), the Canadian Society of Clinical Perfusion ($n = 252$; <http://www.cscp.ca/>), and the American Society of ExtraCorporeal Technology ($n = 1,423$; <http://www.amsect.org/>). The STS was approached for their participation in the survey but did not participate. Surveys were distributed using SurveyMonkey (<http://www.surveymonkey.com/>) and collected between February 2009 and April 2009. The survey was e-mailed to each member weekly, over a 3-week period. The authors were blinded to respondents' contact information, except for institutional information provided by the respondents.

Analysis

Survey responses were prespecified to be excluded from analysis if the respondent self-reported trainee status, was not a practicing anesthesiologist or perfusionist, or completed less than 20 questions in the survey. Summary data for each question excluded those who left the question unanswered. Responses to some questions were conditional on a response to a previous question. In these cases, the percentage responses for the follow-up question were reported based on the total number of responses to the first question. The approximate precision for a point estimate of 50% based upon 1,412 responses is 1.3%, based on the half-length of a 95% confidence interval.

To assess the accuracy of responses, we determined the extent of consensus in responses from respondents within each of 11 Canadian and 19 United States institutions, from which five or more responses were obtained. The percentage of respondents reporting the most frequent response from the institution was estimated. Respondents who reported "Do not know" to a question were excluded from analysis for that question.

Analysis was performed using JMP 8.0.1 (SAS Institute, Cary, NC). Categorical comparisons were made using χ^2 or Fisher's exact tests, where appropriate. Significance was assessed using a two-sided p -value of $< .01$.

RESULTS

Surveys were sent to 6,161 members of the participating societies. Surveys were not received by 442 members because they had opted out of SurveyMonkey mailings ($n = 62$) or the e-mail address was incorrect ($n = 380$). Of 5,719 mailings received by members, 1,828 (32%) surveys were returned by 29% of anesthesiologists and 47% of perfusionists. Responses were excluded from analysis if the respondent self-reported trainee status ($n = 16$), was not a practicing anesthesiologist or perfusionist ($n = 39$), or completed less than 20 questions in the survey ($n = 386$). One thousand four hundred and two returned surveys were used for subsequent analysis. The demographic and professional characteristics of the respondents are reported in Table 1. Responses were received from 891 institutions, principally in the United States (677 institutions) and Canada (34 institutions). Detailed categorized responses are provided as Supplemental Digital Content.

There was wide distribution of the Guidelines with 78% of anesthesiologists and 67% of perfusionists reporting having read all, part, or a summary of the Guidelines. However, only 20% of respondents reported that an institutional discussion had taken place as a result of the Guidelines, and only 14% of respondents reported that an institutional monitoring group had been formed (Table 2). Only 10% reported that both discussion and monitoring groups had been formed. There was wide variability in current preoperative testing, anesthesia, perfusion, surgical, and pharmacological practices reported by respondents (Figures 1–8). Specifically, only three practices were reported by more than 75% of respondents: the routine use of intraoperative red blood cell saving and transfusion of all pump blood, the use of lysine analog antifibrinolytics, and the cessation of antiplatelet drugs before surgery, with the exception of aspirin. Seven practices were reported by less than 25% of respondents: an increased use of off-pump coronary artery bypass surgery, the use of erythropoietin or desmopressin, the use of point-of-care coagulation testing, the use of lowered heparin or activated clotting time levels, the use of a higher hemoglobin level cutoff for a transfusion trigger and routine transfusion of washed shed mediastinal blood. Additionally, many practices were differentially reported by anesthesiologists and perfusionists (Supplemental Digital Content, Appendix 2, Tables 3–9). Sentinel examples are the use of an open venous reservoir reported by 81% of perfusionists, but only 35% of anesthesiologists, and the use of preoperative bleeding time or other equivalent tests in all patients reported by 61% of perfusionists but 18% of anesthesiologists.

Twenty-six percent of respondents reported one or more practice changes in response to the Guidelines. The changes made were reported to be highly (9%) or somewhat effective (31%) in reducing overall transfusion rates.

Individuals who described themselves as institutional leaders were more likely to report the Guidelines as somewhat or highly effective at reducing transfusions while less likely to report they did not know the effect of the Guidelines upon transfusion at their institution. The changes were also reported to be highly (25%) or somewhat (54%) embraced by the respondent's specialty (anesthesiologist or perfusionist) and highly (11%) or somewhat (59%) embraced by the other specialists (anesthesiologist, perfusionist, or surgeon). Only four Guideline recommendations were reported to have motivated a change in clinical practice by more than 5% of respondents. They were a reduced transfusion trigger, use of reduced cardiopulmonary bypass

Table 1. Demographic and professional characteristics of the respondents.

	Anesthesiologist	Perfusionist
Specialty	886	516
Leadership role (Yes)	541 (61)	307 (60)
Years of practice		
0–4 years	128 (14)	31 (6)
5–9 years	156 (18)	42 (8)
10–14 years	149 (17)	57 (11)
15–19 years	168 (19)	94 (18)
≥20 years	285 (32)	292 (57)
Number of cardiac surgical cases personally performed		
<100 cases/year	395 (45)	129 (25)
100–199 cases/year	315 (36)	328 (63)
200–299 cases/year	108 (12)	47 (9)
≥300 cases/year	68 (8)	12 (2)
Type of institution		
Academic, university affiliated institution	432 (49)	175 (34)
Non-academic institution with academic affiliation	185 (21)	145 (28)
Private practice without an academic affiliation	269 (30)	196 (38)
Number of cardiac surgical cases performed at institution		
<200 cases/year	162 (18)	123 (24)
200–399 cases/year	207 (23)	112 (22)
400–599 cases/year	150 (17)	99 (19)
600–799 cases/year	93 (11)	43 (8)
≥800 cases/year	274 (31)	139 (27)
Country		
United States	641	436
Canada	60	61
United Kingdom	30	1
Germany	14	1
Netherlands	16	4
Other European country	39	4
Australia/New Zealand	32	1
Mexico/South America	19	1
Asia and India	19	5
All other countries	4	1
Did respondent read the Society of Thoracic Surgeons/Society of Cardiovascular Anesthesiologists Guidelines		
Yes – all of the Guidelines	297 (33)	127 (25)
Yes – part of the Guidelines	313 (35)	154 (30)
A summary of the Guidelines	81 (9)	66 (13)
No	195 (22)	169 (33)

Results are reported as n (%).

Table 2. Institutional response to guidelines.

	Anesthesiologist	Perfusionist
A formal institutional discussion of the Guidelines		
Yes	179 (20)	110 (21)
No	567 (64)	239 (46)
Don't know	140 (16)	167 (33)
Who participated in the institutional discussion*		
Surgeons	153 (94)	99 (88)
Anesthesiologists	177 (100)	101 (90)
Perfusionists	129 (74)	106 (95)
Blood bankers	101 (73)	67 (60)
Nurses	70 (88)	57 (51)
Others	32 (68)	30 (27)
A formal institutional multidisciplinary group set up to monitor effectiveness		
Yes	118 (13)	85 (17)
No	570 (64)	221 (43)
Don't know	198 (23)	210 (41)
Who participated in the institutional multidisciplinary group*		
Surgeons	103 (87)	69 (79)
Anesthesiologists	110 (93)	68 (78)
Perfusionists	70 (59)	74 (85)
Blood bankers	83 (70)	59 (68)
Nurses	56 (47)	44 (51)
Others	39 (33)	27 (31)
Were any changes in clinical practice implemented?		
Yes	206 (25)	137 (27)
No	425 (51)	199 (40)
Don't know	206 (25)	162 (33)

Results are reported as *n* (%).

*Of those respondents reporting that an institutional discussion was held, or an institutional monitoring group was formed, respectively.

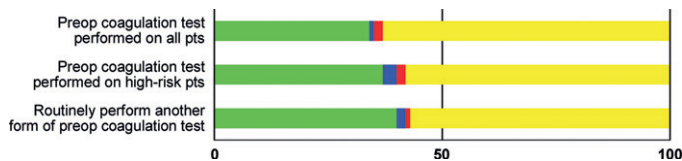


Figure 1. Preoperative hemostasis assessment: Summary of all responses to section 6 of the survey from all respondents (anesthesiologists and perfusionists), reported as percentages. Respondents were instructed to answer “Already” (Green) if you were already performing the test; “New” (Blue) if you stopped as a result of the guidelines; “Unrelated” (Red) if you stopped, not as a result of the guidelines; and “No” (Yellow) if you were not performing the test.

circuit prime volume, use of retrograde autologous cardiopulmonary bypass circuit priming, and routine use of an intraoperative point-of-care hemostasis or platelet function test in all patients who are bleeding.

There were significant ($p < .01$) differences in practices and changes in practice between institutions that conducted an institutional discussion of the Guidelines and those that did not. In general, the percentage of respondents reporting a change in practice within institutions that conducted an institutional discussion of the Guidelines was higher for many of the recommendations (Supplemental Digital Content, Appendix 2, Tables 15–16, 20–21). The percentage of respondents reporting highly or somewhat effective

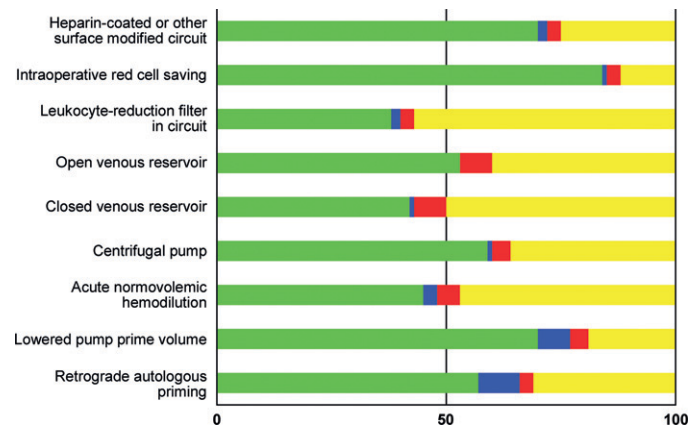


Figure 2. Equipment used for cardiopulmonary bypass: Summary of responses to equipment questions of section 7 of the survey from all respondents (anesthesiologists and perfusionists), reported as percentages. Respondents were instructed to answer “Already” (Green) if you were already doing this; “New” (Blue) if there was a change in practice resulting from the guidelines; “Unrelated” (Red) if there was a change in practice not resulting from the guidelines; and “No” (Yellow) if you do not use the technology.

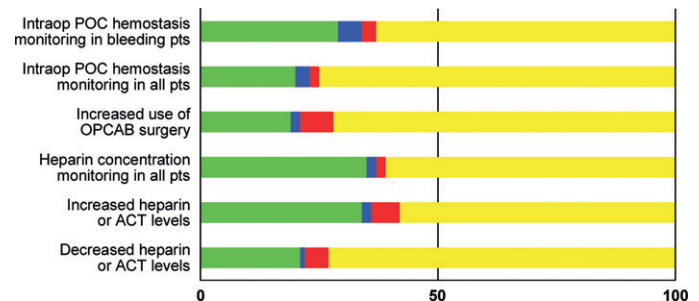


Figure 3. Practices used for cardiopulmonary bypass: Summary of responses to clinical practice questions of section 7 of the survey from all respondents (anesthesiologists and perfusionists), reported as percentages. Respondents were instructed to answer “Already” (Green) if you were already doing this; “New” (Blue) if there was a change in practice resulting from the guidelines; “Unrelated” (Red) if there was a change in practice not resulting from the guidelines; and “No” (Yellow) if you do not use the technology. Abbreviations: pts, patients; intraop, intraoperative; POC, point-of-care; OPCAB, off-pump coronary artery bypass; ACT, activated clotting time.

reductions in transfusion was significantly higher among institutions that conducted an institutional discussion of the Guidelines than those that did not (Supplemental Digital Content, Appendix 2, Table 13A). The percentage of respondents in institutions that conducted an institutional discussion of the Guidelines reporting highly or somewhat effective “embracing” of the changes was significantly higher than those that did not conduct an institutional discussion (Supplemental Digital Content, Appendix 2, Table 13A). These changes were generally not affected by the institution’s academic affiliation (Supplemental Digital Content, Appendix 2, Tables 13C, 22–24, 27–28).

The use of rFVIIa as a rescue therapy in the setting of life-threatening bleeding unresponsive to routine therapy

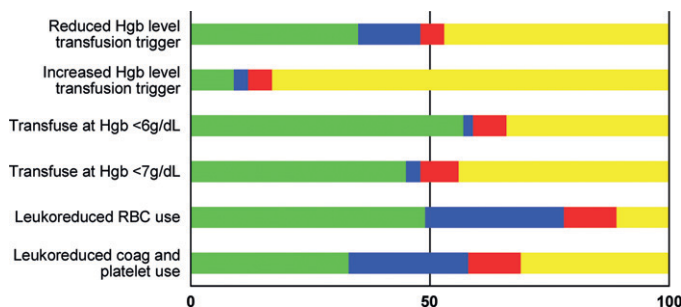


Figure 4. Institutional transfusion practices for cardiac surgery: Summary of responses to section 9 of the survey from all respondents (anesthesiologists and perfusionists), reported as percentages. Respondents were instructed to answer "Already" (Green) if you were already doing this; "New" (Blue) if there was a change in practice resulting from the guidelines; "Unrelated" (Red) if there was a change in practice not resulting from the guidelines; and "No" (Yellow) if you do not use the technique. For the questions referring to leukoreduced blood products the responses were "Always" (Green), "Sometimes" (Blue), "Never" (Red), and "Don't know" (Yellow). Abbreviations: pts, patients; Hgb, hemoglobin; RBC, red blood cell; coag, coagulation factor product.



Figure 5. Institutional use of recombinant factor VIIa (NovoSeven) use during cardiac surgery: Summary of responses to section 11 of the survey from all respondents (anesthesiologists and perfusionists), reported as percentages. Respondents were instructed to answer "Already" (Green) if you were already doing this; "New" (Blue) if there was a change in practice resulting from the guidelines; "Unrelated" (Red) if there was a change in practice not resulting from the guidelines; and "No" (Yellow) if you do not use Factor VIIa.

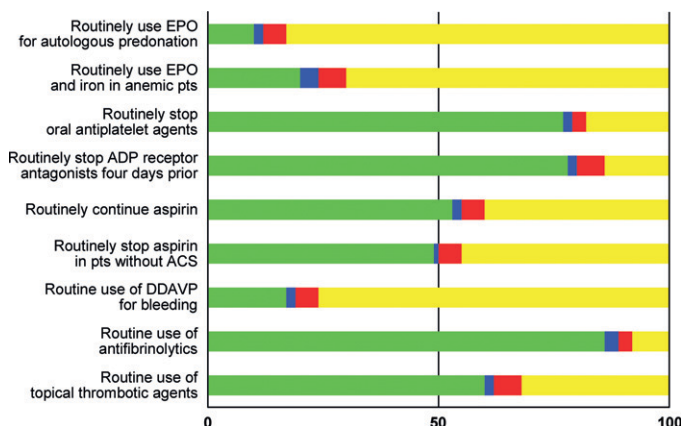


Figure 6. Pharmacologic guidelines for cardiac surgery: Summary of responses to section 13 of the survey from all respondents (anesthesiologists and perfusionists), reported as percentages. Respondents were instructed to answer "Already" (Green) if you were already doing this; "New" (Blue) if there was a change in practice resulting from the guidelines; "Unrelated" (Red) if there was a change in practice not resulting from the guidelines; and "No" (Yellow) if you did not change your practice. Abbreviations: pts, patients; EPO, erythropoietin; ADP, adenosine diphosphate; ACS, acute coronary syndrome; DDAVP, desmopressin.

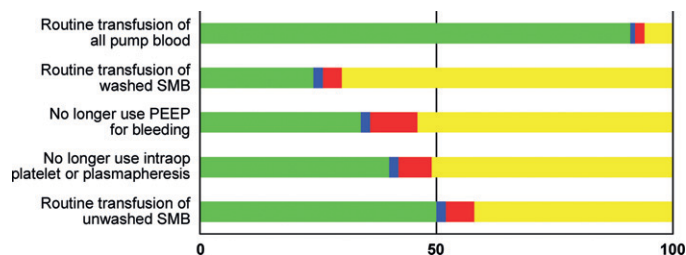


Figure 7. Other institutional practices for cardiac surgery: Summary of responses to section 14 of the survey from all respondents (anesthesiologists and perfusionists), reported as percentages. Respondents were instructed to answer "Already" (Green) if you were already doing this; "New" (Blue) if there was a change in practice resulting from the guidelines; "Unrelated" (Red) if there was a change in practice not resulting from the guidelines; and "No" (Yellow) if you do not use the technology. Abbreviations: SMB, shed mediastinal blood; PEEP, positive end-expiratory pressure; intraop, intraoperative.



Figure 8. Effectiveness of changes: Summary of responses to section 15 of the survey from all respondents (anesthesiologists and perfusionists), reported as percentages. Respondents were instructed to answer "Highly" (Green), "Somewhat" (Blue), "Not at all" (Red), "Increased transfusion" (Yellow), "I do not know" (Light blue), or "We did not measure this" (Brown). For questions referring to personal opinions of specialty response, the respondents were instructed to answer "Highly" (Green), "Somewhat" (Blue), or "Not at all" (Red).

was reported by 65% of respondents. Use of rFVIIa as a first-line therapy for bleeding was reported by 2% of respondents. Only 87 (6%) respondents reported that their institution had systematically examined the effect of rFVIIa upon renal failure and mortality. The most common effect of such institutional examination was restriction in its use, reported by 78% of the 87 respondents. There were no significant differences in rFVIIa use within Western world countries (Supplemental Digital Content, Appendix 2, Table 12).

The use of aprotinin was reported to have been examined in the institutions of 15% of respondents, with a higher rate of examination in institutions that also had an institutional discussion of the guidelines (Supplemental Digital Content, Appendix 2, Tables 6 and 18). Respondents from different types of institutions did not differ in their reported rate of examination of aprotinin use (Supplemental Digital Content, Appendix 2, Table 25).

We determined the extent of consensus for responses from respondents within each of the 11 Canadian and 19 U.S. institutions, from which five or more responses were obtained. Most questions had good ($\geq 75\%$) consistency between respondents from an institution. For several questions, there was low ($<75\%$) agreement from

respondents within the institution regarding current institutional practice. These included whether there had been an institutional discussion of the Guidelines, whether a monitoring group had been formed, whether changes in clinical practice were implemented as a result of the Guidelines, effectiveness of transfusion guidelines, and how well the changes had been embraced by their and other specialties (Supplemental Digital Content, Appendix 3).

DISCUSSION

In this survey of SCA, American Academy of Cardiovascular Perfusion, Canadian Society of Clinical Perfusion, and American Society of ExtraCorporeal Technology members, we observed wide variation in reported clinical practices of cardiac surgery, as related to blood conservation and transfusion. Furthermore, many practices were reported at different frequencies between perfusionists and anesthesiologists, and even among individuals from the same institution. There appeared to be little change in clinical practices attributed to the STS/SCA Guidelines. Respondents from institutions where an institutional discussion of the Guidelines was held were more likely to report changes in practices in response to the Guidelines and to report that the changes were somewhat or highly effective in reducing overall transfusion rates. This observation likely stems from both the credibility of the Guidelines process as well as the institutional support for improvement of care. The responses to the Guidelines were not affected by the type of academic affiliation of the respondent's institution.

The wide variation in reported perfusion, anesthesia, and surgical practices is an important observation, not previously reported in this cohort. Importantly, many of the Guideline recommendations are practiced by less than 50% of the respondents' institutions. Such variation is the rationale for the Guidelines and emphasizes the importance of their promulgation and implementation. The key components for implementation lie in senior leadership and their endorsement of the Guidelines, peer review, and involvement in implementation, along with frequent reinforcement, and even reward, for continued adherence to the Guidelines (13). Moreover, continued and practice-specific feedback of performance is a key component of incorporating clinical practice guidelines into actionable changes within institutions. A sentinel example of effective and widely practiced guidelines are those developed and promulgated by the American Heart Association (AHA), notable for their extensive peer review by all interested stakeholders, wide dissemination and institution-specific feedback at the annual meeting (3). Importantly, the AHA "Get with the Guidelines" program is based on the importance of continued education to improve implemen-

tation. Similar methods have also been successfully used for assessing cardiovascular perfusion care relative to evidence-based guidelines in Northern New England (14). Similarly, Berry et al. recently reported on the redesign of cardiac surgical care by implementing 40 measurable process variables that were rooted in the American College of Cardiology/AHA coronary artery bypass graft guidelines, with reported significant reduction in intensive care unit readmissions and blood product use (15).

Implementation of guidelines in the cardiac surgery arena has been reported to be poor (16,17), but focused implementation of guidelines at single institutions has been reported to be successful (15,18). Important features of successful implementation of guidelines likely include the quality and supporting evidence for the guidelines. The organization(s) promulgating the guidelines may also affect the adoption rate, especially when multiple practitioners from several specialties are affected. Implementation at the institutional level will be highly affected by organizational and peer leadership and the organizational structure within the institution (19).

There was a low level of concordance for some questions from each of the institutions having five or more respondents. Sixty percent or fewer respondents agreed on whether a formal institutional discussion had been held, whether an institutional monitoring group had been formed, or whether any changes in clinical practice had been implemented. Similarly, respondents failed to agree on whether there had been an institutional examination of the effects of aprotinin withdrawal or rFVIIa use, and whether the changes made were effective in reducing overall transfusion rates. The reasons for such lack of concordance are not clear, but may reflect a lack of involvement or communication among all parties, or inaccuracy of the survey methodology.

This survey found infrequent use of technology for timely and definitive monitoring of a patient's coagulation, hemostasis, and platelet function. Additionally, less than 40% of respondents reported using heparin concentration monitoring. The overall low use of technology that may guide specific coagulation product administration may reflect issues of cost and technology effectiveness. However, the use of coagulation assessment may be strongly warranted, notably because the use of platelet inhibitors is frequent, the incidence of coagulopathy is high, and the dose-response relationships for coagulation products are unknown for individual patients.

The formation of an institutional monitoring group did not appear to be completely effective in providing feedback to practitioners. Comparing responses from institutions that did or did not form an institutional monitoring group, 25% of respondents in the "monitoring group formed" category did not receive feedback upon overall transfusion rates (Supplemental Digital Content, Appendix 2, Table 13B),

compared to 55% in the “monitoring group not formed” category. Incorporating evidence-based practice guidelines into practice may be the rate-limiting step for practice change because of broader organizational implications such as displacement of resources, budgetary restrictions, and peer pressure (20). Furthermore, many of the changes resulting from the STS/SCA guidelines and other such documents require system-level modifications, with complex implementation. Quality improvement initiatives used in industry, such as Total Quality Management and Six Sigma, which appear applicable to surgical processes, are dependent on the collection and distribution of quantitative feedback to all individuals involved in the process (21,22). The notion that we can improve cardiac surgical care and the performance of individual members of the team without proper timely feedback is not reasonable. In fact, real-time feedback has been demonstrated to be particularly effective (23).

Guidelines are valuable methods for reducing practice variation, errors, and unnecessary and potentially harmful use of limited health care resources (14). The ever-increasing cost of health care suggests the need for a more methodical approach to redesigning care as well as allocating human and material resources. Guidelines may be an effective tool for minimizing unwarranted variation in practice and may provide reference material for obtaining the resources that are needed to improve care, but we did not observe this for the STS/SCA Guidelines. These findings are in agreement with prior observations that guidelines are frequently poorly, and slowly, adopted (2,24). Reasons for low adoption include practitioner views of outside control of clinical practice, low level of strength of the evidence supporting a given recommendation, appropriateness and usefulness of the specific guidelines, and availability of resources to implement the guidelines (25–27). These factors may be important in the reported low adoption of the STS/SCA Guidelines.

This survey has limitations. One of the most serious was the absence of participation by surgeons. Furthermore, only 32% of those polled responded to the survey. Although this is a common response rate for professional surveys, the overall accuracy would have been enhanced by a greater response rate. Individual society members who had not provided a current e-mail address were excluded from the survey due to the cost associated with individual mailings. Nevertheless, more than 90% of SCA members and 80% of perfusion society members had provided e-mail addresses and were polled. Surveys are subject to two major sources of error: incomplete sampling and misinterpretation of the survey questions by respondents. The former results in sampling bias error and the latter produces responses that do not accurately reflect clinical practice or respondent opinions. It is possible that individuals with the greatest interest in blood conservation measures, and who therefore may

have instituted more changes in institutional practices, may have responded at a greater rate than those who were not, and may have been more optimistic about their positive effect. Thus, the low reported rate of clinical practice change and adoption of the Guidelines recommendations may be even worse than that reported by the responders to our survey. Furthermore, both types of error could result in ascribing inappropriate inferences from the responses. Similarly, surveys may not reflect actual clinician or institutional behavior and may be prone to bias. Specifically, we do not know the basis or validity for a respondent's response that changes made had been effective at reducing overall transfusion rate. Therefore these results should be regarded with caution until validated by direct institutional observation (28). Nor does the survey define or directly assess effectiveness of the Guidelines or any specific Guideline.

Adoption of the Guidelines' recommendations may also have been hindered by the sometimes ambiguous nature of the recommendations, especially the use of the AHA Guideline phrases “it is not unreasonable” and “it is reasonable.” The distinctions in this phraseology are not well understood by clinical practitioners and may not provide sufficient imperative for adoption. Common to many guidelines, the relatively low level of evidence for many recommendations (40/57 had only class B or lower level of evidence) may not have provided sufficient impetus to institutional change. Furthermore, many of the recommendations require redesigning complex institution-wide processes to implement, which may further reduce compliance.

In summary, this survey emphasizes the obligations of clinical groups and all individuals involved in the management of cardiac surgical patients. At the level of those formulating practice guidelines, there is a mandate to involve all interested parties at every level of formulation and promulgation of evidence-based guidelines. Societies and other organizations have a key role in endorsement, dissemination, and use of guidelines to improve care. At the institutional level, those with leadership roles have an obligation to involve hospital leadership, practitioners, those with support roles, and even practitioners beyond the hospital environs with the tools and mandate to practice patient-centered, cost-effective, and guideline-oriented care of the cardiac surgical patient.

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