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Original contribution

Anesthesiologists' preferences for preoperative cardiac evaluation before vascular surgery: results of a mail survey☆

John E. Ellis MD (Adjunct Professor)[a,*], Avery Tung MD (Professor)[b], Helen Lee MD, MPH (Acting Assistant Professor)[c], Hubert Lee BA (Member)[d], Kristen Kasza MS (Biostatistician)[e]

[a]*Department of Anesthesiology and Critical Care Medicine, University of Pennsylvania School of Medicine, Philadelphia, PA 19104, USA*
[b]*Department of Anesthesiology and Critical Care, The University of Chicago, Chicago, IL 60637, USA*
[c]*Department of Anesthesiology and Pain Medicine, University of Washington, Seattle, WA 98105, USA*
[d]*Fairfax Medical Reserve Corps, Fairfax County Health Department, Fairfax, VA 22030, USA*
[e]*Department of Health Studies, The University of Chicago, Chicago, IL 60637, USA*

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Abstract

Study Objective: To investigate whether anesthesiologists' decisions to request preoperative cardiac evaluation (cardiologist consultation, echocardiography, and cardiac stress testing) before vascular surgery were influenced by patient comorbidity and magnitude of surgery; and to explore whether factors unrelated to the American College of Cardiology/American Heart Association (ACC/AHA) guidelines influence these decisions.

Design: Survey instrument.

Setting: University medical center.

Subjects: 2,000 U.S. anesthesiologists who were mailed a survey.

Measurements: Six factors in a hypothetical patient presenting for vascular surgery [gender, race (white vs. black), age (65 yrs vs. 85 yrs), comorbidities (sick vs. healthy), functional status, and magnitude of surgical stress] were evaluated. Respondents were asked about their demographics, practice patterns, and how they would manage the hypothetical patient.

Main Results: Of 2,000 mailed surveys, 439 U.S. anesthesiologists responded (22%). Multivariate ordinal logistic regression analysis showed that anesthesiologists were more likely to recommend preoperative cardiology consultation for patients with more comorbidities [odds ratio = 5.53; 95% confidence interval (CI) = 3.76, 8.15], for those with poorer functional status (odds ratio = 1.45; 95% CI = 1.02, 2.07), for those undergoing a more significant surgery (odds ratio = 1.61; 95% CI = 1.13, 2.30), as the clinicians' estimated risk of perioperative myocardial infarction increased ($P < 0.001$), or if they only infrequently anesthetized patients such as the one described in the scenario ($P = 0.05$). They also would request a preoperative echocardiogram for patients with more comorbidities (odds ratio = 2.58; 95% CI = 1.80, 3.68) and for

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* Corresponding author.
E-mail address: johnellis1700@gmail.com (J.E. Ellis).

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those undergoing a more significant surgery (odds ratio = 1.59; 95% CI = 1.12, 2.25). A preoperative stress test was recommended for patients with more comorbidities (odds ratio = 3.01; 95% CI = 2.06, 4.38) and for those with a more significant surgery (odds ratio = 1.74; 95% CI = 1.15, 2.63). Other factors associated with request for a preoperative stress test were female gender of the anesthesiologist (odds ratio = 1.79; 95% CI = 1.11, 2.87), those with less experience with such patients ($P = 0.05$), and those from New England (odds ratio = 2.16; 95% CI = 1.01, 4.62).

Conclusions: Anesthesiologists' preferences for preoperative cardiac evaluation are generally consistent with evidence-based and expert-based AHA/ACC guidelines. However, other physician factors (ie, gender, years in practice, and familiarity with the surgical procedure) also influenced these decisions.
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1. Introduction

For patients undergoing vascular surgery, the possible presence of coronary artery disease (CAD) is particularly important to the anesthesiologist. Some series suggest that approximately half of vascular surgery patients have significant CAD. During vascular surgery, this comorbidity may result in clinically significant perioperative complications, including myocardial ischemia, myocardial infarction (MI), arrhythmia, congestive heart failure, and cardiac death. Much of the preoperative preparation of such patients is focused on defining cardiac risk and possibly defining cardiac function and coronary perfusion [1].

Of late, there has been a movement towards less preoperative cardiac testing as studies have suggested that specific pharmacologic prophylaxis can protect vascular surgery patients. Such pharmacologic protective approaches include beta blockers, statins, and aspirin [2]. Nonetheless, the American College of Cardiology/American Heart Association (ACC/AHA) Guidelines on Perioperative Cardiac Evaluation – and other guidelines – continue to recommend as an option the targeted use of preoperative cardiac evaluation in patients suspected of having CAD before major vascular surgery [3,4].

Abundant evidence shows that decision making differs amongst physicians and may diverge from that predicted by available evidence [5-8]. Although the reasons for this divergence are incompletely understood, inadequate practice-based learning, heuristic driven behavior, errors in self assessment, age, and cynicism about the validity of medical evidence have all been hypothesized to play a role. To better understand these factors, decision preferences were examined in a mail survey of United States-based anesthesiologists with respect to preoperative care of a hypothetical patient undergoing vascular surgery.

2. Materials and methods

After approval by the University of Chicago Institutional Review Board, a 6-page paper survey was mailed to 2,000 randomly selected anesthesiologists in the U.S. in November, 2003. (Randomization during this study was via a random numbers generator.) Names, addresses, and demographic information were obtained from the American Medical Association (AMA) database via a commercial mailing house (Medical Marketing Service, Inc., Wood Dale, IL, US). This database was used because the AMA collects extensive information on all U.S. physicians, and it includes anesthesiologists who are not members of the ASA. The survey queried respondents about their demographics, their practice arrangements and patterns, and how they would evaluate and anesthetize a hypothetical complex elderly patient presenting for vascular surgery.

Six variables in the patient presentation section of the survey were randomly changed using the Microsoft Word "Mail Merge" feature to produce 64 different questionnaires. We randomly varied the magnitude of vascular surgery (femoral-distal bypass vs. aortobifemoral bypass); severity of medical comorbidities [hypertension, diabetes, previous MI, and moderate stable exertional dyspnea (sick) vs. hypertension alone (healthy)]; gender; race (black vs. white); age (65 vs. 85 yrs of age), and functional status (living with daughter and gardening vs. living in a nursing home) (Appendix A).

These variations were then randomly distributed among survey recipients. Anesthesiologists were asked about their propensity to seek more cardiac information before and during surgery for the hypothetical patient. The choices included cardiologist consultation, preoperative echocardiogram, and preoperative stress test; they were not mutually exclusive. Respondents were asked to rate their desires on a 5-point Likert scale, with 1 = "would not recommend" and 5 = "strongly recommend". Their preferences for perioperative management, including choice of anesthetic technique, use of intraoperative monitors, and their estimates of the likelihood of perioperative MI or death, also were queried. Regarding general practice issues, physicians were asked about their level of training; practice remuneration model; hospital size; and experience with elderly patients, vascular surgery, and invasive hemodynamic monitoring. Finally, demographic information such as gender, age, ethnicity, and geographic location (zip code of primary practice locale was determined) was surveyed.

Surveys were mailed once in November 2003. Data entry was closed 6 months later. We did not use follow-up mailings. No monetary or raffle-type incentives were used to encourage response.

2.1. Statistical analysis

Differences between responders and non-responders were examined using two-sample t tests for continuous variables and chi-square tests for categorical variables. Univariate and multivariate ordinal logistic (proportional odds) regression were used to identify physician and patient factors associated with preoperative cardiac evaluation recommendations. In addition, each outcome was treated as a continuous variable and linear regression models were fitted. Since conclusions based on these models were similar to those from the ordinal logistic regression models, only results from the latter are reported. Variables with P-values ≤ 0.15 in univariate models were included in the initial multivariate model. A backward elimination procedure was then used to determine which variables could be deleted from the model, using a 0.05 significance level. Values presented are means ± SD unless otherwise noted. All analyses were carried out using Stata, Version 9 software (Stata Corp., College Station, TX, USA).

3. Results

Of the 2,000 surveys mailed, 439 anesthesiologists responded, for an overall response rate of 22%. Several differences between respondents and non-respondents were noted. Respondents were younger (49.9 ± 8.6 yrs vs. 52.3 ± 10.6 yrs; $P < 0.0001$, t-test) and also had less "experience" (defined as yrs after completing training; 17.1 ± 9.0 yrs vs. 18.8 ± 10.2 yrs; $P = 0.0008$, t-test). Respondents also were more likely to have graduated from a medical school in the U.S. (80.6% vs. 67.6%; $P < 0.001$, chi-square test). Respondents represented 9 geographical regions: New England (6.6%), Mid-Atlantic (15.3%), South-Atlantic (16.4%), East North Central (18.7%), East South Central (4.8%), West North Central (6.6%), West South Central (8.2%), Mountain (7.1%), and Pacific (16.4%). Survey response rates in different regions of the country ranged from 18.2% to 26.3%, and there were no geographical differences between responders and non-responders ($P = 0.33$, chi-square test). Sixty-nine physicians reported their race as "non-white": 8 Black, 4 Native American, 11 Hispanic, and 46 Asian. Forty-one (9.3%) physicians did not report their race. Other demographic and practice characteristics of respondents are listed in Table 1. Table 2 summarizes the Likert scores for each of the three preoperative cardiac evaluation strategies.

Factors independently associated with increased physician preference for a cardiologist consultation (Table 3), preoperative echocardiogram (Table 4), and preoperative stress testing (Table 5) were similar. These factors included greater patient comorbidity, greater magnitude of surgery, and a higher estimate of the risk of perioperative MI by the clinician. For cardiologist consultation, poorer functional status of the patient and less experience anesthetizing such patients resulted in greater likelihood of requesting a consultation (Table 3). Preoperative echocardiograms were less likely to be requested by cardiac anesthesiologists (ie, those whose practice included 21% or more of patients presenting for cardiac surgery cases) than by those with no current cardiac anesthesia experience (Table 4). Physicians with fewer years of practice, women anesthesiologists, and physicians from New England were more likely to request a preoperative stress test, while physicians who rarely or never place pulmonary artery (PA) catheters were less likely to request one than those who place them on a daily basis. In addition, preference for a preoperative stress test increased as the anesthesiologist's estimation of expected patient blood loss during surgery increased (Table 5).

Table 1 Demographics and practice characteristics (n = 439)

	N (%)
Race	
Caucasian	329 (74.9)
Other	69 (15.7)
Unknown	41 (9.3)
Gender	
Male	339 (77.2)
Female	85 (19.4)
Unknown	15 (3.4)
Practice locale	
Urban	193 (44.0)
Suburban	189 (43.0)
Rural+other	51 (11.6)
Unknown	6 (1.4)
Practice setting	
< 250 beds	112 (25.5)
250-500 beds	156 (35.5)
> 500 beds	60 (13.7)
University	58 (13.2)
Other	45 (10.3)
Unknown	8 (1.8)
Anesthesia fellowship training	
No	286 (65.1)
Yes	153 (34.9)
Years post-residency	
0-5	33 (7.5)
5-10	100 (22.8)
10-15	101 (23.0)
15-20	83 (18.9)
> 20	115 (26.2)
Unknown	7 (1.6)
Reimbursement type	
Fixed	119 (27.1)
Fee-for-service	109 (24.8)
Partnership	186 (42.4)
Other	20 (4.6)
Unknown	5 (1.1)
Medical school location	
U.S.	354 (80.6)
Other	85 (19.4)

Table 2 Respondents' requests for preoperative cardiovascular evaluation

Likert score	Cardiologist consultation		Echocardiogram		Stress test	
	Frequency	%	Frequency	%	Frequency	%
1	56	12.84	62	14.35	63	14.55
2	80	18.35	75	17.36	79	18.24
3	46	10.55	84	19.44	80	18.48
4	130	29.82	87	20.14	111	25.64
5	124	28.44	124	28.70	100	23.09
All	436	100	432	100	433	100

Respondents were asked to rate their desires on a 5-point Likert scale, with 1 = "would not recommend" and 5 = "strongly recommend".

Assuming that all patients in the scenario presented for high-risk surgery (and excluding race and gender variables), if one uses the ACC/AHA paradigm, patients may be categorized into one of the 4 groups: 1) minor clinical risk factors (healthy) with good functional capacity; 2) minor clinical risk factors (healthy) with poor functional capacity; 3) moderate clinical risk factors (sick) with good functional capacity; and 4) moderate clinical risk factors (sick) with poor functional capacity. Based on the 2002 guidelines, patients in Groups 2, 3, and 4 could be considered for further testing. The results in Table 6 show highly significant *P*-values from comparison of the Likert scale scores across the 4 patient groups using the Kruskal-Wallis test for all three interventions (echocardiography, cardiology consult, stress test).

4. Discussion

The factors governing a request for preoperative cardiac evaluation made by anesthesiologists in a hypothetical vascular surgery case were generally consistent with AHA/ACC guidelines. Requesting preoperative cardiac consultation or testing may be perceived as "protecting" anesthesiologists in the event of complications. Although anesthesiologists were not asked about such perceptions, the tendency to avoid ambiguity has been well documented in decision research [9].

The association of more experience (as measured either by yrs of practice or by frequency of anesthetizing patients such as the one in the scenario) with less preoperative testing may be due to physicians having trained in an earlier era when stress tests were performed much less often, or perhaps greater self-perceived skill in estimating and/or mitigating risk without testing. This finding is consistent with previous literature, which finds that older physicians are less likely to follow external guidelines or perform comprehensive histories and physical examinations [6]. However, respondents were not asked about self-perceived skill or age-related training bias, nor was the ability of experienced physicians to discern perioperative risk assessed. The finding that cardiac anesthesiologists reported less desire for a preoperative echocardiogram might have resulted from greater familiarity

Table 3 Results of multivariate ordinal logistic regression: predictors of anesthesiologists' request for a preoperative cardiologist consultation

Variable	Odds ratio	95% Confidence interval	*P*-value
Patient characteristics			
Comorbidity (sick vs. healthy)	5.53	(3.76, 8.15)	< 0.001
Surgery (aortic vs. femoral)	1.61	(1.13, 2.30)	0.009
Functional status (nursing home resident vs. lives with daughter and gardens)	1.45	(1.02, 2.07)	0.04
Perioperative MI likelihood as assessed by anesthesiologist			< 0.001
0-1% (ref)	1.00		
1-5%	2.26	(1.22, 4.18)	
5-10%	3.54	(1.86, 6.74)	
> 10%	4.55	(2.11, 9.80)	
Physician characteristics			
Frequency of anesthetizing similar patients			0.05
daily (ref)	1.00		
weekly	1.33	(0.77, 2.28)	
monthly	1.73	(0.95, 3.15)	
rarely or never	2.50	(1.23, 5.08)	

MI = myocardial infarction, ref = reference group.

Table 4 Results of multivariate ordinal logistic regression: predictors of anesthesiologists' request for a preoperative echocardiogram

Variable	Odds ratio	95% Confidence interval	*P*-value
Patient characteristics			
Comorbidity (sick vs. healthy)	2.58	(1.80, 3.68)	< 0.001
Surgery (aortic vs. femoral)	1.59	(1.12, 2.25)	0.009
Perioperative MI likelihood as assessed by anesthesiologist			< 0.001
0-1% (ref)	1.00		
1-5%	2.28	(1.20, 4.36)	
5-10%	3.51	(1.80, 6.86)	
> 10%	5.96	(2.73, 13.02)	
Physician characteristics			
Cardiac anesthesia practice %			0.007
0 (ref)	1.00		
≤ 20	0.67	(0.45, 1.00)	
21-100	0.47	(0.28, 0.79)	

MI = myocardial infarction, ref = reference group.

and expertise in managing such patients, or perhaps the ability to perform intraoperative transesophageal echocardiography (TEE). However, familiarity with TEE was not assessed. Alternatively, they might have been more comfortable with a "worst case" scenario where cardiac function is impaired. Lastly, data suggest that preoperative echocardiography does not have additive predictive value over the clinical history [10]. In internal medicine settings comparing hospitalists with internists who attend less frequently in the hospital, both use of resources and mortality decreased with the physician's cumulative experience in caring for a patient's primary diagnosis [11]. Why anesthesiologists with daily PA catheter experience were more likely to recommend a preoperative stress test than those who use them rarely or never is unclear and merits further study.

Table 5 Results of multivariate ordinal logistic regression: predictors of anesthesiologists' request for a preoperative stress test

Variable	Odds ratio	95% Confidence interval	*P*-value
Patient characteristics			
Comorbidity (sick vs. healthy)	3.01	(2.06, 4.38)	< 0.001
Surgery (aortic vs. femoral)	1.74	(1.15, 2.63)	0.009
Perioperative MI likelihood as assessed by anesthesiologist			0.004
0-1% (ref)	1.00		
1-5%	3.15	(1.63, 6.07)	
5-10%	2.84	(1.44, 5.63)	
> 10%	3.83	(1.73, 8.44)	
Expected blood loss (per 100-unit increase)	1.09	(1.02, 1.17)	0.009
Physician characteristics			
Gender (female vs. male)	1.79	(1.11, 2.87)	0.02
Region (New England vs. other)	2.16	(1.01, 4.62)	0.05
Frequency of pulmonary artery catherization in practice			0.002
daily (ref)	1.00		
weekly	0.60	(0.27, 1.35)	
monthly	0.90	(0.38, 2.11)	
rarely	0.41	(0.19, 0.91)	
never	0.29	(0.12, 0.70)	
Experience			0.05
0-5 yrs (ref)	1.00		
5-10	0.73	(0.35, 1.53)	
10-15	0.59	(0.28, 1.23)	
15-20	0.47	(0.22, 1.01)	
> 20	0.39	(0.19, 0.82)	

MI = myocardial infarction, ref = reference group.

Respondents were asked about their preferences for each evaluation strategy (cardiologist consultation, echocardiogram, stress test) separately. However, these decisions may not be independent. Respondents might, for example, see a stress test as a substitute for an echocardiogram, or order a cardiology consult only if a stress test or echocardiogram were abnormal.

The finding that female anesthesiologists were more likely than their male colleagues to request preoperative stress tests is surprising. This finding was true even after controlling for experience (female respondents having less experience than males). Recently, female physicians were shown to be more likely to comply with guidelines for care of chronic heart failure than were male physicians [12].

Anesthesiologists from New England were significantly more likely to request a preoperative stress test before vascular surgery than were those from the other regions, even after controlling for experience and patient factors. New England physicians were more likely to use beta blockade after MI [13], and they were also more likely to provide perioperative beta blockade than were other U.S. anesthesiologists [14].

The study has flaws. Because different guidelines may recommend different preoperative strategies in the same patient [15], differences from practice may represent an allegiance to a competing guideline. We also did not specify the type of stress test to be ordered. The stress test of choice

Table 6 Comparison of Likert scale scores across the 4 patient groups for all three interventions (echocardiography, cardiology consult, stress test)

Group	Cardiologist consult		Echocardiography		Stress test	
	Mean (SD)[†], median	%[‡]	Mean (SD), median	%	Mean (SD), median	%
1. Healthy, good function (n = 118)	2.6 (1.3) 2	7.7	2.9 (1.4) 3	20.5	2.7 (1.4) 3	12.8
2. Healthy, poor function (n = 113)	3.1 (1.4) 3	19.5	3.1 (1.4) 3	21.2	3.0 (1.3) 3	14.2
3. Sick, good function (n = 108)	4.0 (1.2) 4	45.4	3.6 (1.3) 4	34.9	3.7 (1.3) 4	33.6
4. Sick, poor function (n = 100)	4.1 (1.1) 4	44.9	3.8 (1.2) 4	40.6	3.7 (1.3) 4	34.4
P-value*	< 0.001		< 0.001		< 0.001	

* Kruskal-Wallis test. All *P*-values were highly significant; with such a large sample size, smaller differences are detectable.
† 5-point Likert scale (1 = "would not recommend" and 5 = "strongly recommend").
‡ Percentage of respondents who strongly recommended evaluation (ie, score of 5 on Likert scale).

may vary from institution to institution, and in sensitivity and specificity [16,17].

Use of preoperative stress testing has been criticized of late as being overly sensitive, generating many false-positives and false-negatives [18,19]. Some researchers have suggested that aggressive medical therapy is protective in vascular surgery, obviating the need for stress testing. The Coronary Artery Revascularization Prophylaxis (CARP) study also has questioned the benefits of prophylactic preoperative cardiac revascularization [2]. The recent randomized study by Poldermans et al. [20] suggests that intermediate-risk patients who were given a beta blocker (heart rate < 65 bpm) had similar cardiovascular outcomes after vascular surgery when compared with intermediate-risk patients who had undergone stress testing, then subsequent coronary revascularization when deemed appropriate.

The findings have other limitations. The survey response rate was 22%. In mail surveys of Canadian anesthesiologists, response rates ranged from 47% to 70% [21-23]. We chose not to use inducements or second mailings to increase response rates, but rather relied on mailing a large initial sample of 2,000 surveys. Non-response may produce misleading results [24]; those physicians who responded to this survey were in fact younger and had less experience than those who did not respond (but only by a yr or two, on average). Stratification and oversampling (eg, of minority physicians) might have added more clarity. In addition, given the 64 total different scenarios, the number of respondents answering a given scenario was likely to be small, and we cannot assume that the 6 factors independently influenced an individual's choices (eg, a combination of poor functional status and multiple comorbidities might synergistically change physician decision making). The results were obtained before the most recent 2007 update of the AHA/ACC guidelines [4], which suggest less use of preoperative stress testing than did the 2002 version [3].

An earlier survey [25] suggested a somewhat greater use of preoperative cardiac evaluation before vascular surgery (54% to 73%) than was identified in our survey. Another survey, performed more recently, identified widely differing goals amongst different specialists (anesthesiologists, cardiologists, and surgeons) for preoperative cardiologist evaluation [26]. However, our respondents were not asked about their goals or rationales for test selection, so results are not comparable. All surveys suffer from the limitation of recording what clinicians report they would do, rather than recording what they actually do in the course of daily practice. In contrast, Hoecks et al. used chart reviews in 11 Dutch hospitals to show that AHA/ACC guidelines for preoperative stress testing were followed only in 21% of 711 consecutive vascular surgery patients for whom the guidelines suggested a test [27]. However, the authors could not show that the use of testing or not affected outcome [28]. As some series suggest that preoperative testing does not improve outcomes [20,29], clinicians who say they would not order stress tests do have some evidence on their side. In addition, the patients in the scenarios were not receiving a beta blocker, antiplatelet agent, or a statin. This situation might have influenced our respondents' desires for preoperative consultation or testing. While the medical therapy of some of our hypothetical patients might have been inadequate, undertreatment of vascular surgery patients remains common [30].

Anesthesiologists' decisions regarding preoperative cardiac evaluation before vascular surgery are based both on factors outlined in the AHA/ACC guidelines as well as other factors. These results were obtained in the setting of a survey that varied patient demographics, surgical stress, functional status, and medical comorbidity so as to seek to show preferences. Disparities in recommended workups by gender or race of patients were not detected. Interestingly, we noted that patients' ages did not play a significant role in the decision process. In addition, as all of the patients were elderly, clinicians might not have distinguished between the two age groups. The greater reported desire for preoperative cardiac evaluation by anesthesiologists

who were women, New Englanders, or who had less experience bears further study.

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Appendix A

Please tell us how you would handle the following clinical situations:

Mr./Ms. Jones is an (65/85) year-old, hypertensive (black/white) (male/female), who presents to you for an anesthetic for (femoral distal bypass/aorto-femoral bypass). (S)he has a (history of an MI and PTCA 2 years ago, her EF = 35%, and takes Lisinopril, Lasix, and Digoxin/no history of coronary artery disease and takes Lisinopril). S/he lives (with his/her daughter and enjoys gardening/in a nursing home).

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