Anesthesiology 2007; 107:537–44

Guidelines for Cardiac Management in Noncardiac Surgery Are Poorly Implemented in Clinical Practice

Results from a Peripheral Vascular Survey in The Netherlands

Sanne E. Hoeks, M.Sc., Wilma J. M. Scholte op Reimer, Ph.D.,† Mattie J. Lenzen, Ph.D.,† Hero van Urk, M.D., Ph.D.,‡ Paul J. G. Jörning, M.D., Ph.D.,§ Eric Boersma, Ph.D.,‖ Maarten L. Simoons, M.D., Ph.D.,# Jeroen J. Bax, M.D., Ph.D.,** Don Poldermans, M.D., Ph.D.††*

Background: **The American College of Cardiology (ACC)/American Heart Association (AHA) guidelines for Perioperative Cardiovascular Evaluation for Noncardiac Surgery recommend an algorithm for a stepwise approach to preoperative cardiac assessment in vascular surgery patients. The authors' main objective was to determine adherence to the ACC/AHA guidelines on perioperative care in daily clinical practice.**

Methods: **Between May and December 2004, data on 711 consecutive peripheral vascular surgery patients were collected from 11 hospitals in The Netherlands. This survey was conducted within the infrastructure of the Euro Heart Survey Programme. The authors retrospectively applied the ACC/AHA guideline algorithm to each patient in their data set and subsequently compared observed clinical practice data with these recommendations.**

Results: **Although 185 of the total 711 patients (26%) fulfilled the ACC/AHA guideline criteria to recommend preoperative noninvasive cardiac testing, clinicians had performed testing in only 38 of those cases (21%). Conversely, of the 526 patients for whom noninvasive testing was not recommended, guidelines were followed in 467 patients (89%). Overall, patients who had not been tested, irrespective of guideline recommendation, received less cardioprotective medications, whereas patients who underwent noninvasive testing were significantly more often treated with cardiovascular drugs (β-blockers 43% *vs.* 77%, statins 52% *vs.* 83%, platelet inhibitors 80% *vs.* 85%, respectively; all $P < 0.05$). Moreover, the authors did not observe significant differences in cardiovascular medical therapy between patients with a normal test result and patients with an abnormal test result.**

Conclusion: **This survey showed poor agreement between ACC/AHA guideline recommendations and daily clinical practice. Only one of each five patients underwent noninvasive testing when recommended. Furthermore, patients who had not undergone testing despite recommendations received as little cardiac management as the low-risk population.**

This article is accompanied by an Editorial View. Please see: Spahn DR, Chassot P-G, Zaugg M: Pragmatic treatment *versus* elaborative but incomplete testing: A Hobon's choice? ANESTHESIOLOGY 2007; 107:526–9.

* Research Fellow, †† Professor, Department of Anaesthesiology, † Clinical Epidemiologist, ‖ Clinical Epidemiologist, # Professor, Head of Department, Department of Cardiology, ‡ Professor, Head of Department, Department of Vascular Surgery, Erasmus Medical Center, Rotterdam, The Netherlands. § Staff Surgeon, Isala Klinieken, Zwolle, The Netherlands. ** Professor, Department of Cardiology, Leiden Medical Center, Leiden, The Netherlands.

Received from the Department of Anaesthesiology, Erasmus Medical Center, Rotterdam, The Netherlands. Submitted for publication January 5, 2007. Accepted for publication June 28, 2007. Supported by grant No. 2000T101 from the Dutch Heart Foundation, The Hague, The Netherlands.

Address correspondence to Dr. Poldermans: Erasmus Medical Center, Dr. Molewaterplein 40, 3015 GD Rotterdam, The Netherlands. d.poldermans@erasmusmc.nl.

PATIENTS undergoing vascular surgery are known to be at increased risk of perioperative mortality and other cardiac complications due to frequently underlying (a)symptomatic coronary artery disease. Mortality rates of 1.5–2% for endovascular procedures and 3–4% for surgical repair have been reported.[1,2] Myocardial infarction accounts for 10–40% of postoperative fatalities and can therefore be considered as the major determinant of perioperative mortality associated with noncardiac surgery.[3–5] Furthermore, a nonfatal myocardial infarction in the perioperative period is associated with a 20-fold increased risk of late mortality.[6]

When considering a patient for vascular surgery, a careful preoperative clinical risk evaluation and subsequent risk-reduction strategies are essential to reduce postoperative cardiac complications. The American College of Cardiology (ACC)/American Heart Association (AHA) guidelines, which are commonly used in clinical practice in The Netherlands, recommend an algorithm for a stepwise approach to preoperative cardiac assessment (fig. 1).[7] This decision-making process integrates clinical markers, early coronary evaluation, functional capacity, and the type of surgery planned. According to the guidelines, preoperative noninvasive testing is recommended for all patients undergoing high-risk procedures and patients with intermediate clinical predictors of perioperative complications and poor functional capacity undergoing intermediate-risk surgery.

Several studies showed that this stepwise approach to the assessment of significant coronary artery disease is both efficacious and cost effective.[8,9] However, the use of such preoperative cardiac evaluation does not seem to predict or improve outcome.[10–12] In addition, little is known about the adherence to the ACC/AHA guidelines in daily clinical practice and the effect on patient outcome. Therefore, the primary aim of this study was to determine to what extent the ACC/AHA guidelines are followed in routine clinical practice.

Materials and Methods

Study Population

Between May and December 2004, a survey of routine clinical practice was conducted in 11 hospitals in The Netherlands (see appendix). This survey was conducted within the infrastructure of the Euro Heart Survey Programme in The Netherlands, which evaluates the imple-

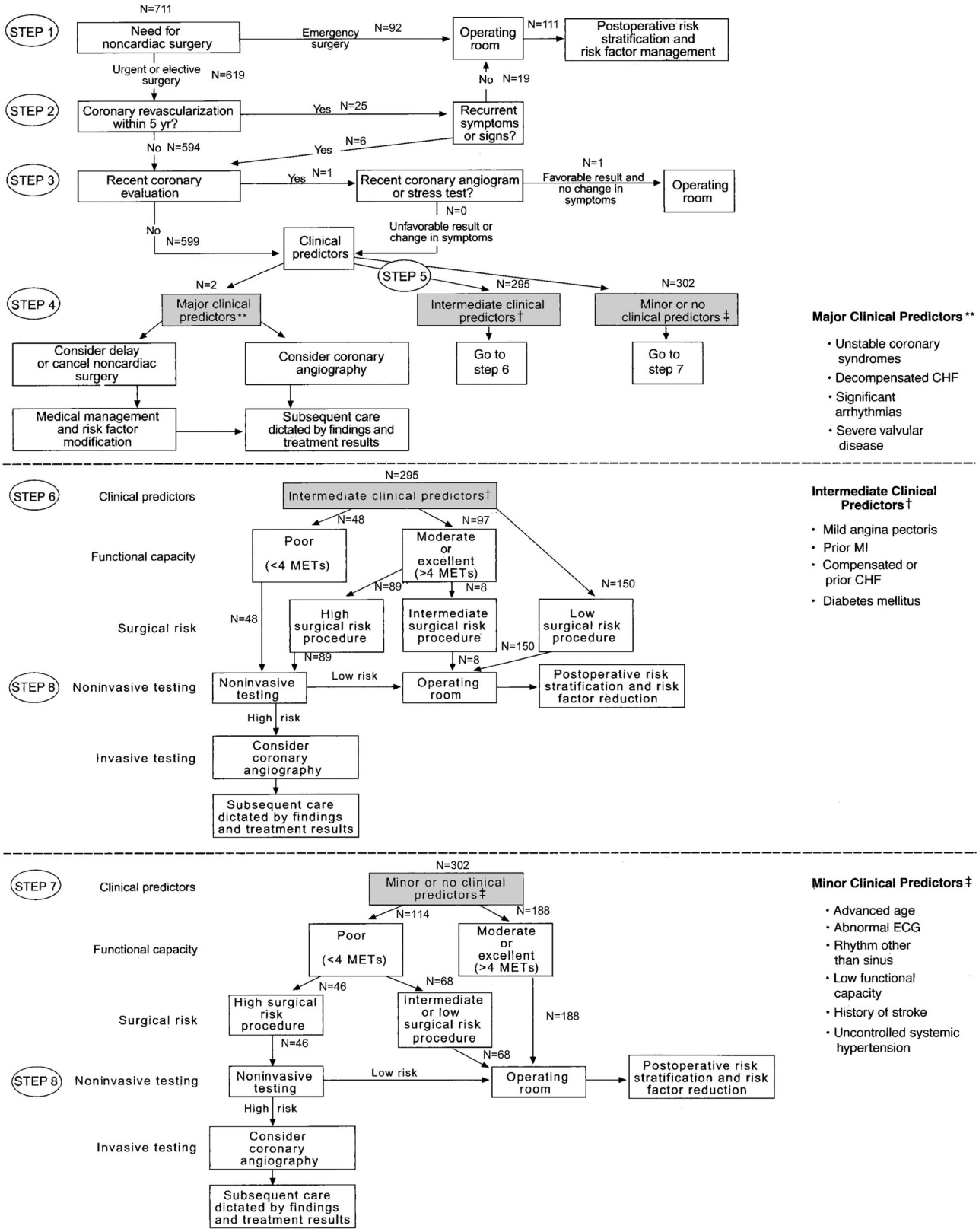

Fig. 1. Application of the American College of Cardiology/American Heart Association algorithm for perioperative cardiovascular evaluation for noncardiac surgery to the study population. Adapted from Eagle *et al.*[7], with permission. CHF = congestive heart failure; ECG = echocardiogram; MET = metabolic equivalent; MI = myocardial infarction.

mentation of guidelines in daily clinical practice. Five hospitals were located in the central part of the country, 3 were located in the northern region, and 3 were located in the southern region. Two centers were university hospitals, which act as tertiary referral centers.

All consecutive patients who were admitted to the vascular surgery department of the participating hospital were screened. Patients older than 18 years who were undergoing peripheral vascular repair were eligible for participation in the survey, except those undergoing thoracic or brain surgery. The total study population consisted of 711 patients. Patients had to provide informed consent. The medical ethics committees of the participating hospitals approved the study.

Data Collection

Trained research assistants obtained data on patient characteristics, applied diagnostic procedures, cardioprotective treatment, and the surgical procedure from the patients' hospital charts. All data were entered into the electronic Case Record Form and transferred regularly to the central database at the Erasmus Medical Center (Rotterdam, The Netherlands) *via* the Internet. Data entered into the electronic case record form were automatically checked for completeness, internal consistency, and accuracy. The data management staff at the Erasmus Medical Center performed additional edit checks. If necessary, queries were resolved with the local research assistants.

ACC/AHA Guidelines

The ACC/AHA Task Force published Practice Guidelines for Perioperative Cardiovascular Evaluation for Noncardiac Surgery in 1996 and an update in 2002.[7] The core of the ACC/AHA guidelines is an algorithm that summarizes the stepwise process leading to practical recommendations as performing noninvasive testing (fig. 1).[7] According to this algorithm, after the urgency of the surgery and the cardiac status of patients having previous coronary revascularization within 5 yr or previous cardiac evaluation within 2 yr are assessed, the patients are classified as major, intermediate, or minor perioperative cardiovascular risk. Major, intermediate, and minor clinical predictors of risk, together with surgical risk and degree of functional capacity, can be determined as predictors of perioperative cardiac complications. Patients with only minor or intermediate clinical predictors and adequate functional capacity represent a low-risk population, irrespective of type of surgery, and further evaluation is unnecessary. However, if any of the clinical markers of cardiac risk present, additional noninvasive evaluation should be considered.

The main purpose of performing preoperative cardiac risk assessment is to identify patients at high risk for perioperative cardiac events. In general, two strategies have been used to reduce the incidence of perioperative myocardial infarctions and other cardiac complications: preoperative coronary revascularization and pharmacologic treatment. The ACC/AHA guidelines recommend β-blockers for patients at high cardiac risk. Evidence for statins and β-blockers in intermediate-risk patients is less clearly described.

We applied the ACC/AHA guideline definitions to the study population. Because the guidelines were not explicit on the definition of advance age, we defined it as older than 70 yr. Poor functional capacity was defined as a patient being unable to walk four blocks on level ground or climb two flights of stairs without symptomatic limitation. Procedures were divided into high, intermediate, and low surgery-specific risk. High-risk procedures included major vascular surgery, and intermediate-risk procedures included carotid endarterectomy. Endovascular procedures were defined as low-risk procedures.

Endpoints

This survey was designed to evaluate the application of guidelines in patients undergoing peripheral vascular surgery. We specifically looked at noninvasive imaging, cardiovascular medication (β-blockers, statins, and antiplatelet therapy), and preoperative revascularization. Antiplatelet therapy included aspirin, dipyridamole, clopidogrel, or any of combination of these agents. All-cause mortality and adverse events were reported at 30 days and 1 yr after surgery by the local research assistants. Cardiovascular complications were defined as cardiac death, myocardial infarction, cardiac arrhythmias, congestive heart failure, cerebrovascular events, or revascularization.

Data Analyses

For each patient in our data set, we retrospectively determined whether ACC/AHA guidelines were followed. We described the number of patients for whom guidelines were followed with percentages and corresponding confidence intervals (CIs). Differences in following guidelines were analyzed with chi-square tests and Fisher exact test, when appropriate. Mortality rates were only described with percentages and CIs because small subgroup sample sizes limited statistical power for statistical testing. All statistical analyses were undertaken using version 13.0 of the SPSS program for Windows (SPSS Co., Chicago, IL). In all analyses, a P value less than 0.05 was considered statistically significant.

Results

The mean age of the total 711 patients was 67 yr (SD = 10 yr), with many patients having a history of associated risk factors (table 1). When stratified into surgery-specific risk categories according to the ACC/AHA guide-

Table 1. Baseline Characteristics (n = 711)

Demographics	
Mean age ± SD, yr	67 ± 10
Male sex, n (%)	496 (70)
Cardiovascular history, n (%)	
Angina pectoris	99 (14)
Myocardial infarction	106 (15)
Heart failure	38 (5)
Stroke or TIA	123 (17)
Arrhythmia	77 (11)
Valvular disease	50 (7)
Previous revascularization	116 (16)
Clinical risk factors, n (%)	
Obesity	77 (11)
Current smoker	256 (36)
Hypertension	273 (38)
Diabetes mellitus	149 (21)
Renal insufficiency	51 (7)
COPD	101 (14)
Procedure, n (%)	
Low risk	354 (50)
Intermediate risk	29 (4)
High risk	328 (46)
Functional capacity, n (%)	
Poor	240 (34)
Moderate	471 (66)

COPD = chronic obstructive pulmonary disease; TIA = transient ischemic attack.

lines, 328 (46%) underwent high-risk procedures, 29 patients (4%) underwent intermediate-risk procedures, and 354 (50%) underwent low-risk procedures. The 328 open vascular procedures included infrainguinal arterial reconstruction (52%), abdominal aortic surgery (42%), and 21 other procedures (6%).

Risk Evaluation

As shown in the algorithm in figure 1, 92 of the total 711 patients (13%) underwent emergency surgery. Of the 619 patients undergoing urgent or elective surgery, 25 patients (4%) underwent recent coronary revascularization, of which 19 patients had no recurrent symptoms or signs. One other patient had a recent coronary evaluation without recurrent symptoms or unfavorable results. According to the ACC/AHA guidelines algorithm, those patients can undergo surgery directly without previous noninvasive testing. The remaining 599 patients were classified according to the guidelines as having major (n = 2), intermediate (n = 295), and minor or no clinical risk predictors (n = 302). Depending on this clinical risk profile, functional capacity and surgical risk profile, noninvasive testing is recommended as shown in the algorithm and outlined in table 2. For example, within the 295 patients with intermediate clinical risk factors, 48 patients had a poor functional capacity and are recommended to undergo noninvasive testing, whereas the 150 patients undergoing low-surgical-risk procedures can go directly to surgery. In total, 185 patients (26%) fulfilled the criteria to recommend preoperative noninvasive cardiac testing. However, clinicians had performed testing in only 38 of those cases (21%; 95% CI, 15–28%). Of those 38 patients, 17 (45%) had abnormal test results. Conversely, of the 526 patients for whom testing was not recommended, guidelines were followed in 467 patients (89%; 95% CI, 86–91%) in clinical practice, as shown in the last columns of table 2. So 59 (11%; 95% CI, 9–14%) patients were noninvasively tested while not recommended.

As inherent to the algorithm, the 185 patients who fulfilled the guideline criteria to undergo noninvasive cardiac testing had a significantly higher cardiac risk profile than the patients for whom testing was not recommended (table 3). In clinical practice, a sex difference was observed because 84% of those patients who

Table 2. Agreement with the ACC/AHA Guidelines Regarding Noninvasive Testing

ACC/AHA Guideline Category			Noninvasive Testing Recommended			
			Yes		No	
Clinical Category	Functional Capacity	Surgical Risk	Expected According to Guidelines	Observed in Clinical Practice	Expected According to Guidelines	Observed in Clinical Practice
Emergency					92	89 (97%)
Revascularization within 5 yr					19	13 (68%)
Recent coronary evaluation					1	1 (100%)
Major			2	1 (50%)		
Intermediate		Low			150	128 (85%)
Intermediate	Poor		48	9 (19%)		
Intermediate	Moderate/excellent	Intermediate			8	6 (75%)
Intermediate	Moderate/excellent	High	89	20 (23%)		
Minor or no	Poor	Intermediate/low			68	64 (94%)
Minor or no	Poor	High	46	8 (17%)		
Minor or no	Moderate/excellent				188	166 (88%)
Total			185	38 (21%)	526	467 (89%)

ACC = American College of Cardiology; AHA = American Heart Association.

Table 3. Differences in Baseline Characteristics

	Guideline Recommendation			Observed in Clinical Practice		
	Testing Not Recommended (n = 526)	Testing Recommended (n = 185)	*P* Value	Testing Not Performed (n = 614)	Testing Performed (n = 97)	*P* Value
Demographics						
Mean age ± SD, yr	67 ± 11	68 ± 9	0.084	67 ± 11	67 ± 9	0.716
Male sex, n (%)	360 (68)	136 (73)	0.196	415 (68)	81 (84)	0.002
Cardiovascular history, n (%)						
Angina pectoris	59 (11)	40 (22)	<0.001	72 (12)	27 (28)	<0.001
Myocardial infarction	68 (13)	38 (21)	0.012	83 (14)	23 (24)	0.009
Heart failure	27 (5)	10 (5)	0.886	37 (6)	1 (1)	0.046
Stroke or TIA	99 (19)	24 (13)	0.070	109 (18)	14 (14)	0.422
Arrhythmia	44 (8)	33 (18)	<0.001	69 (11)	8 (8)	0.378
Valvular disease	31 (6)	19 (10)	0.045	44 (7)	6 (6)	0.726
Previous revascularization	83 (16)	33 (18)	0.515	89 (15)	27 (28)	0.001
Clinical risk factors, n (%)						
Obesity	53 (10)	24 (13)	0.275	63 (10)	14 (14)	0.219
Current smoker	188 (36)	68 (37)	0.805	229 (37)	27 (28)	0.071
Hypertension	181 (34)	92 (50)	<0.001	232 (38)	41 (42)	0.399
Diabetes mellitus	90 (17)	59 (32)	<0.001	131 (21)	18 (19)	0.532
Renal insufficiency	33 (6)	18 (10)	0.117	44 (7)	7 (7)	0.986
COPD	70 (13)	31 (17)	0.248	86 (14)	15 (16)	0.702
Procedure, n (%)			<0.001			0.007
Low risk	353 (67)	1 (1)		320 (52)	34 (35)	
Intermediate risk	29 (6)	0		23 (4)	6 (6)	
High risk	144 (27)	184 (99)		271 (44)	57 (59)	
Functional capacity, n (%)			<0.001			0.795
Poor	146 (28)	94 (51)		208 (34)	32 (33)	
Moderate	380 (72)	91 (49)		406 (66)	65 (67)	

COPD = chronic obstructive pulmonary disease; TIA = transient ischemic attack.

underwent noninvasive testing were men, compared with 68% males in the not-tested group ($P = 0.002$). Furthermore, tested patients were more likely to have evidence of an ischemic heart disease. Regarding the procedural risk, we observed a clear difference between guideline recommendation and clinical practice because one third of the tested patients underwent a low-risk procedure, whereas testing was hardly recommended in this group.

Risk Modification

Regarding the above guideline-based risk evaluation, differences were observed in cardiovascular medical therapy among different subgroups of patients. Overall, patients who had not been tested, irrespective of guideline recommendation, received less cardioprotective medications, whereas patients who underwent noninvasive testing were significantly more often treated with cardiovascular drugs (β-blockers 43% *vs.* 77%, statins 52% *vs.* 83%, platelet inhibitors 80% *vs.* 85%, respectively; all $P < 0.05$). No differences in medical treatment were observed between patients who had not been tested in accordance and discordance with the guidelines (β-blockers 42% *vs.* 48%, statins 52% *vs.* 52%, platelet inhibitors 80% *vs.* 78%, respectively; all $P > 0.20$; fig. 2).

Moreover, we did not observe significant differences in cardiovascular medical therapy between patients with a normal test result and patients with an abnormal test result. For example, in the 38 patients who were tested according to the guidelines, the percentages of β-blocker users were 71% and 77% for patients with normal and abnormal test results, respectively ($P = 0.73$). These percentages are in line with the group tested while not recommended, 78% in patients with a normal test result, and 83% in patients with an abnormal result ($P = 0.60$). Preoperative revascularization was observed in a small number of patients.

Thirty-six patients (5%) had cardiovascular complications within 30 days after surgery. In patients treated according to the guidelines with respect to noninvasive testing, the percentage complications at 30 days was 7% (95% CI, 5–9%). In contrast, the complication rate was 4% (95% CI, 1–7%) in patients tested in discordance with the guidelines. After 1 yr, total mortality was 11%. Mortality was 11% (95% CI, 8–14%) in patients tested according to the guidelines and 12% (95% CI, 8–16%) in patients who were tested in discordance with the guidelines.

Discussion

The value of using the ACC/AHA guidelines in patients undergoing vascular surgery is still under debate. Whereas some demonstrated improved risk stratification[8–9] and decreased resource use,[13] others showed that this did not result in a beneficial outcome.[10–12,14] Our study demon-

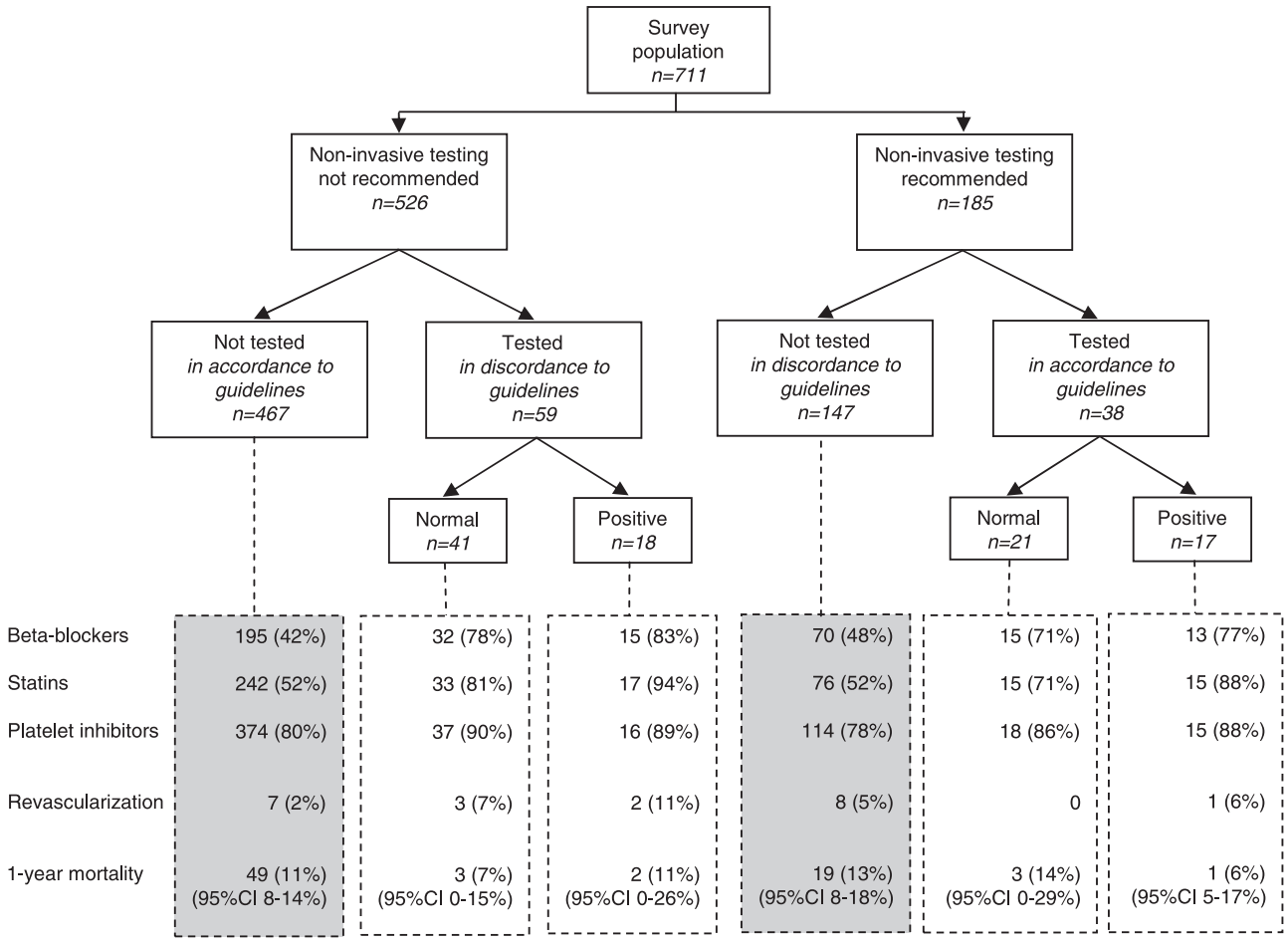

Fig. 2. Risk evaluation and modification. CI = confidence interval.

strated poor agreement between clinical practice and the ACC/AHA guideline recommendations for perioperative cardiovascular evaluation for noncardiac surgery. Only one of each five patients underwent noninvasive testing when recommended. Furthermore, high-risk patients defined by ACC/AHA guidelines who did not undergo testing although recommended, received as little cardiac management as the low-risk population.

The core of the ACC/AHA guidelines is an algorithm that summarizes the stepwise process leading to practical recommendations as performing noninvasive cardiac testing. In general, two strategies have been used to reduce the incidence of perioperative myocardial infarctions and other cardiac complications: preoperative coronary revascularization and pharmacologic treatment. In recent years, more attention has focused on the role of pharmacologic treatment, whereas controversy remains to the appropriate management of patients identified preoperatively as having significant but correctable coronary artery disease. In our study population, only a small number of patients underwent preoperative coronary revascularization. Recently, the Coronary Artery Revascularization Prophylaxis trial demonstrated that in the short term, there is no reduction in the number of postoperative myocardial infarctions, deaths, or duration of stay in the hospital, or in long-term outcomes in patients who underwent preoperative coronary revascularization compared with patients who received optimized medical therapy.[15] These findings apply to patients with stable coronary artery disease, but the optimal perioperative management for patients with left main disease, severe left ventricular dysfunction, unstable angina pectoris, and aortic stenosis must be investigated in controlled clinical trials.

Besides coronary revascularization, an extensive preoperative cardiac evaluation with noninvasive cardiac testing might improve outcome by inciting an improvement in medical management in the perioperative period. Perioperative β-blockers and statins have in this way shown a significant benefit in decreasing perioperative cardiac mortality and morbidity.[16–18] Because of increasing evidence of the beneficial effect of β-blocker in the perioperative period, recently the guidelines section on perioperative β-blocker therapy is updated.[19] Results on β-blocker use from this survey, published before, showed an underuse of β-blockers in vascular surgery patients and also in high-risk patients.[20] In the current study, we found that patients who had not been tested, irrespective of guideline recommendation, re-

ceived less cardioprotective medications compared with patients who underwent noninvasive testing. All of these patients were apparently regarded as a low-risk population and consequently received less medical treatment. Thus, high-risk patients in whom testing was recommended but who did not undergo testing received low medical therapy comparable to that of the real low-risk population. That is, underdiagnosis seems to lead to undertreatment. Conversely, patients who were tested while it was not recommended were medically treated as high-risk patients. This was irrespective of the test result.

A variety of barriers to guideline adherence have been pointed out: out-of-date guidelines; lack of awareness, agreement, or self-efficacy; lack of outcome expectancy; the inertia of previous practice; and external barriers.[21] It should also be noted that the treatment of individual patients is more complex than simply following guidelines. In addition, the algorithm proposed in the guidelines had to rely predominantly on observational data and expert opinion because there were no randomized trials to help define the process. Several of those barriers may be responsible for the poor adherence to guidelines as we observed. For example, the ACC/AHA guidelines do not incorporate the Revised Cardiac Risk Index, which is nowadays a commonly used perioperative risk-stratification approach in the selection of noninvasive cardiac testing and medical treatment in the intermediate-risk patients. Furthermore, the recent DECREASE-II study showed that cardiac testing for intermediate-risk patients before major vascular surgery, as recommended by the guidelines of the ACC/AHA, provided no benefit in patients receiving β-blocker therapy with tight heart rate control.[22] In addition, the ACC/AHA guidelines recommend that the patient's functional capacity should be incorporated into the overall risk assessment. Although many studies have indeed shown that better functional capacity indicates a better long-term survival,[23] good exercise tolerance does not necessarily signify the absence of significant coronary disease. Furthermore, patients with severe peripheral artery disease frequently have intermittent claudication that can give limitations to the assessment of functional capacity and could therefore be not a very good discriminative factor in this patient population. Another reason for the poor adherence to guidelines that we observed may be a lack of agreement between guidelines. In addition to the ACC/AHA guidelines, the American College of Physicians also developed guidelines for preoperative risk assessment. A recent study reported that the recommendations for preoperative cardiac testing significantly differed when applying these two different guidelines.[24] Successful perioperative evaluation and management of high-risk cardiac patients undergoing noncardiac surgery requires careful teamwork and communication between the surgeon, anesthesiologist, cardiologist, and patient's primary care physician. In addition, the algorithm of the ACC/AHA guidelines could be too complicated for use in routine care, as evident by several publications of the ACC/AHA algorithm as a simplified formula.[25] This reflects that guidelines must be straightforward, simple to use, uniform, and based on recent scientific evidence.

The limitations of this study are those inherent to observational studies involving voluntarily participating hospitals. Although we included a wide spectrum of hospitals, the results could be biased toward better-than-average practices. Nevertheless, because patient inclusion was consecutive in all participating sites, we trust that the survey depicts ongoing clinical practice. It should be noted also that our study was limited by its sample size, reflected by the limited number of patients in the subgroups. Larger studies are needed to confirm observed findings.

In conclusion, our study showed poor agreement between ACC/AHA guideline recommendations and daily clinical practice for both noninvasive testing and cardiac management.

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Appendix: Investigators and Research Assistants

Harry J. Crijns, M.D., Ph.D., Petra Erkens, R.N., Rose-Miek M. A. Eterman, M.Sc., Nezar Gadalla, M.D., Miguel Lemmert, M.D., Robby Nieuwlaat, M.Sc., Jan H. M. Tordoir, M.D., Ph.D., and Cees de Vos, M.D. (University Hospital Maastricht, Maastricht, The Netherlands); Herman Broers, R.N., Steef E. Kranendonk, M.D., Ph.D., Ine Schraa, R.N., and Jobst P. Winter, M.D., Ph.D. (TweeSteden Hospital, Tilburg, The Netherlands); Robert J. Heintjes, M.D., Ph.D., and Joan G. Meeder, M.D., Ph.D. (VieCuri, Venlo, The Netherlands); Adrie van den Dool, R.N., Rene J. A. Estourgie, M.D., Ph.D., and Christ J. P. J. Werter, M.D. (Laurentius Hospital, Roermond, The Netherlands); Jan-Dirk Banga, M.D., Ph.D. (University Medical Center Utrecht, Utrecht, The Netherlands); Rudolf P. Tutein Nolthenius, M.D., Ph.D. (Albert Schweitzer Hospital, Dordrecht, The Netherlands); Emile J. Th. A. M. Van Emstede, M.D., Ph.D. (Diaconessenhuis, Meppel, The Netherlands); Adrie M. Blomme, M.R., Christel Ephraim, R.N., Paul J. G. Jörning, M.D., Ph.D., and Ingrid Middelveld, R.N. (Isala Klinieken, Zwolle, The Netherlands); Sanne E. Hoeks, M.Sc., Chris Jansen, R.N., Maria Kamps, R.N., Don Poldermans, M.D., Ph.D., Wilma J. M. Scholte op Reimer, Ph.D., Hero van Urk, M.D., Ph.D., and Saskia Versluis, R.N. (Erasmus Medical Center, Rotterdam, The Netherlands); Andre A. E. A. de Smet, M.D., Ph.D., and Dammis Vroegindeweij, M.D., Ph.D. (Medical Centre Rijnmond-Zuid, Rotterdam, The Netherlands); Arie C. Van Der Ham, M.D. (Sint Fransiscus Gasthuis, Rotterdam, The Netherlands); Willem L. Akkersdijk, M.D. (Hospital St. Jansdal, Harderwijk, The Netherlands).