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Pre-operative Cardiac Stress Testing in the Southern California Vascular Outcomes Improvement Collaborative

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Abstract

Objective—The objective of this study is to examine the use of pre-operative cardiac stress testing (PCST) in the Southern California Vascular Outcomes Improvement Collaborative (So Cal VOICe).

Methods—A retrospective review was performed of data in all modules of the So Cal VOICe from September 2012 through May 2016. PCST was defined as stress echocardiogram or nuclear stress test. A new post-operative myocardial infarction (MI) was defined as troponin elevation and/or electrocardiogram/imaging changes with or without ischemic symptoms. Only elective cases in patients with asymptomatic cardiac status were included in the study.

Results—During the study period 3,063 procedures meeting the inclusion criteria were performed in eight registries: peripheral vascular intervention (PVI), carotid endarterectomy (CEA), carotid artery stent (CAS), thoracic endovascular aneurysm repair (TEVAR), infra-inguinal bypass (Infra), endovascular aneurysm repair (EVAR), supra-inguinal bypass (Supra) and open abdominal aneurysm repair (OAAA). PCST varied across registries from 17% in PVI to 62% in OAAA (Table). PCST in CEA varied across nine institutions from 10% to 79%. PCST in EVAR varied across seven institutions from 14% to 83%. PCST in Infra varied across four institutions from 10% to 57%. Of the 12 patients across all registries who had a new MI, six had PCST, one of which was abnormal.

Conclusion—The incidence of PCST varies widely across registries and institutions in the So Cal VOICe. Despite the wide variation, the incidence of new post-operative MI is exceptionally low. Further studies should evaluate the cost-effectiveness of the PCST practices and future quality improvement efforts should focus on standardization of indications for PCST.

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1. Introduction

Cardiac stress testing prior to peripheral vascular operations has long been a controversial issue. One of the first major studies addressing this issue was a retrospective analysis of registry data published in 1995 of nearly 2000 patients with coronary artery disease who also had peripheral artery disease or cerebro-vascular disease.[1] This study demonstrated that surgical coronary artery intervention provided a long-term survival benefit. This was followed by the Coronary Artery Revascularization Prophylaxis (CARP) trial published in 2004.[2] In the CARP trial, 510 patients undergoing elective open abdominal aortic aneurysm repair or elective revascularization for lower extremity occlusive disease were randomized to pre-operative coronary revascularization or aggressive medical management. The study demonstrated no difference in post-operative mortality or five-year survival between the two groups.

More recently, the American College of Cardiology (ACC) and the American Heart Association (AHA) released guidelines in 2014 regarding the indications for peri-operative cardiac evaluation and management of patients undergoing noncardiac surgery.[3] The ACC/AHA guidelines indicate that low and moderate risk patients with good functional capacity do not require stress testing. The only patients who require peri-operative cardiac stress testing (PCST) are moderate risk patients with poor or unknown functional capacity in whom further testing would impact decision making.

Despite the recommendations and the evidence, a recent study estimated that the excess cost of peri-operative cardiac testing overuse in the Medicare population alone ranged from $81 million to $180 million.[4] Other studies have demonstrated that adherence to guidelines can reduce the incidence of inappropriate use of peri-operative cardiac testing without increasing the risk of peri-operative cardiac events.[5–7] The objective of this study is to examine the regional variation of PCST use in the Southern California Vascular Outcomes Improvement Collaborative (So Cal VOICe) and to investigate the possible drivers of that variation.

2. Methods

A retrospective review was conducted of all data entered into the arterial registries in the So Cal VOICe from September 2012 through May 2016. The So Cal VOICe is one of 17 regional quality groups of the Vascular Quality Initiative® (VQI). Procedures performed in seven different registries were included: carotid endarterectomy (CEA), carotid artery stent (CAS), thoracic endovascular aneurysm repair (TEVAR), infra-inguinal bypass (Infra), endovascular aneurysm repair (EVAR), supra-inguinal bypass (Supra), and open abdominal aortic aneurysm repair (OAAA).

Peri-operative cardiac stress testing (PCST) was defined as either a stress echocardiogram or cardiac nuclear stress testing. Only patients undergoing elective operations with no history of coronary artery disease, defined as angina, myocardial infarction or any previous coronary artery intervention, were included. Within four procedure registries (CEA, EVAR, Infra, and TEVAR), with adequate volume of cases per institution per registry, variation in stress test frequency was assessed by center. New postoperative myocardial infarctions (MI) is defined

in the VQI as troponin elevation and/or electrocardiogram/imaging changes with or without ischemic symptoms. The incidence of MI overall and by registry was assessed. Due to the very low incidence on MI overall and per registry, it was not possible to perform a risk adjusted analysis regarding the association of PCST with MI.

A survey was performed of So Cal VOICe participants regarding PCST practices at their respective institutions. The survey was administered electronically through a commercially available survey creation and administration program. All So Cal VOICe participants received an email regarding the survey and at least one response per institution was requested. The survey asked participants about the utilization of pre-operative resting echocardiogram, PCST, the influence of cardiac evaluation results on their choice of operation, and what they believed to be the drivers for performance of pre-operative cardiac stress testing. The respondents were asked to assume that the patient did not have a known history of coronary artery disease, cardiac valvular disease, previous coronary artery revascularization or symptoms of coronary artery or valvular disease.

3. Results

During the study period 1,866 procedures performed at eleven centers met the inclusion criteria in the seven procedure registries: carotid endarterectomy (CEA) – 902; carotid artery stenting (CAS) – 108; thoracic endovascular aneurysm repair (TEVAR) – 150; infrainguinal bypass (INFRA) – 263; infrarenal endovascular aneurysm repair (EVAR) – 294; suprainguinal bypass (SUPRA) – 86; and open abdominal aortic aneurysm repair (AAA) − 63. Overall, 667 (36%) patients received a PCST prior to their procedure. There were slightly more males in the patient group that underwent PCST than in the group that did not (69% vs 63%, p = .008). Otherwise, there was no significant difference between the two groups with respect to age, white race, smoking, diabetes, dialysis dependence and chronic obstructive pulmonary disease (Table 1). In the stress test group, 98% of patients lived at home prior to the operation and 98% were independently ambulatory or ambulatory with assistance.

Across all registries, the frequency of PCST ranged from 29% in CEA to 62% in OAAA (Figure 1a). The frequency of PCST by center varied from 11% to 66% (Figure 1b). Within the CEA registry, PCST varied across nine centers from 10% to 79% (Figure 2a). There was also a wide variation in the EVAR registry, with PCST ranging from 14% to 83% across seven centers (Figure 2b). In the infrainguinal bypass registry, usage ranged from 10% to 57% across four centers (Figure 2c). In the three centers in the TEVAR registry, stress testing varied from 0% to 35% (Figure 2d). Variation by center is not shown for the remainder of the registries due to low volume per center.

In the majority of the cases, PCST results were normal; ranging from 67% normal in the CEA registry to 93% in the TEVAR registry (Table 2). There was a total of 12 new recorded postoperative myocardial infarctions (MI) in six of the registries. Six occurred in patients who underwent PCST and six occurred in patients who did not undergo PCST. Overall, the stress test group had a new MI rate of 0.9% while the group without stress tests had a rate of 0.5%.

In the CAS, AAA, and SUPRA registries, there was one patient in each registry who had a post-operative MI who also had a PCST that was normal (Table 2). In the EVAR registry, four patients had new postoperative MIs, two of whom underwent PCST, both of which were normal. The patient who suffered a postoperative MI in the INFRA registry did not undergo PCST. Four patients in the TEVAR registry developed new postoperative MIs - one of which underwent PCST which was normal (Table 2).

Twenty-two participants at eleven sites responded to the So Cal VOICe survey regarding PCST practices at their institutions. Forty percent of respondents estimated that pre-operative resting echocardiograms were performed in more than 75% of patients at their institution. (Figure 3a) Half of the respondents thought that rate of pre-operative resting echocardiogram at their institution was too high and the other half thought it was just right (Figures 3b). Half of the respondents estimated that at least 50% of their patients undergo PCST (Figure 3c). More than half of the respondents felt that this rate was too high (Figures 3d). Over 50% of respondents report that the PCST resulted in a delayed or cancelation of their case at least 50% of the time when PCST was ordered. Despite this, more than 80% of respondents reported that the results of the PCST rarely changed their operative plans (Figure 3f). Over 60% of respondents reported anesthesiology as the most common driver of ordering the PCST and over 50% reported risk stratification as the most commonly reported reason for the PCST.

4. Discussion

The ACC/AHA guidelines indicate that low and moderate risk patients with good functional capacity do not require stress testing.[3] The guidelines also indicate that the only patients who require stress testing are moderate risk patients with poor or unknown functional capacity in whom further testing would impact decision making. These recommendations are supported by numerous studies and reviews that have demonstrated that PCST confers no advantage in reduction of post-operative myocardial infarction in low- and moderate-risk patient subgroups.[8–12] In fact, cardiac imaging as a pre-operative assessment in patients scheduled to undergo low-or intermediate- risk non-cardiac surgery has been deemed inappropriate as part of the Choosing Wisely campaign by the American Society of Nuclear Cardiology and is one of the five things that the society recommends physicians and patients should question.[13]

In our study, there were five patients who experienced post-operative MI who underwent PCST with normal results. This suggests that the results of PCST do not correlate with risk of post-operative MI. Other authors have demonstrated that there is no association between reversible defects on dipyridamole-thallium/sestamibi cardiac scan and adverse post-operative cardiac events in moderate-risk patients undergoing elective vascular surgery.[12] This study found the sensitivity of the scan for a cardiac event to be 11%, specificity of 90% and positive and negative predictive values of 12.5% and 89%.

The large variation in PCST across centers within the So Cal VOICe in this group of patients undergoing elective vascular surgery with no history or symptoms of coronary artery disease suggests that guidelines are not being adhered to uniformly among So Cal VOICe

participants. Large variations in practice patterns indicate areas where standardization of care may be able to decrease practice variation and decrease utilization of resources. One way to do this is through the implementation of standardized clinical assessment and management plans (SCAMPS). These are standardized care pathways that utilize decision trees to allow for the care of individualized patients and take into account physician expertise and preference.[14] Implementation of a SCAMP for the evaluation of pediatric chest pain in one institution significantly decreased the practice variation and decreased utilization of resources; there was a 26% decrease in the number of exercise stress tests obtained, a 66% decrease in Holter monitors and a 75% decrease in long-term event monitors.[15]

The results of the So Cal VOICe survey indicate that participants believe inappropriate utilization of PCST is occurring in their institutions and that the practice is being driven by providers other than vascular surgeons. The only recommendations on PCST from anesthesiologists comes from a joint recommendation from the European Society of Cardiology and the European Society of Anesthesiology. Their recommendations state that stress testing is recommended for high or intermediate risk surgery in patients with a combination of clinical risk factors and poor functional capacity. Thus, it is unclear what guidelines anesthesiologists in the United States use as the basis to recommend PCST.

Further, a PubMed search of all journals with a title containing the term “anesthesia”, “anesthesiology”, “anaesthesia” or “anaesthesiology” and articles containing the term “pre-operative cardiac” yielded one study on non-cardiac surgery from the United Kingdom, published in 1997.[16] The investigators performed a survey of the pre-operative assessment of patients undergoing elective aortic aneurysm repair. The respondents were 54% anesthetists and 26% cardiologists. The extent of use of further cardiac investigation for pre-operative assessment ranged from 0% to 100%. No data was collected on the indication for further cardiac investigation. Otherwise, the anesthesia literature reveals little regarding the anesthetists’ view toward the wide variation in incidence of pre-operative cardiac testing.

There are weaknesses in our study that arise from data that is not collected in the VQI. The indication for the stress test, whether it was performed as part of a pre-operative evaluation or for diagnostic or other reasons, is not recorded. However, it is extremely unlikely that any of these stress tests were performed for symptomatic coronary artery disease as all patients with angina were excluded. VQI also does not record whether abnormal stress test resulted in coronary revascularization. However, it is extremely unlikely that patients with abnormal PCST who then underwent coronary revascularization prior to vascular surgery are included in this study since all patients with history of coronary revascularization were excluded. Finally, we are unable to determine from this data which patients would benefit from a cardiac evaluation and thus we are unable to develop any recommendations from this data regarding who should and should not undergo PCST.

The VQI does not collect cost or charge data. Nevertheless, Medicare reimbursement rates in Southern California can give us a suggestion of the cost of all the PCST that is performed in the So Cal VOICe. The figures shown here represent the average of the seven localities that Medicare considers to be in Southern California. For cardiac stress echocardiogram, the

professional fee is $75.81 and the technical fee is $192.82. For nuclear stress test, the professional fee is $71.49 and the technical fee is $329.45.

5. Conclusion

There was wide variation in the usage of preoperative cardiac stress testing among participants in the So Cal VOICe. Despite this variation among centers, the incidence of postoperative myocardial infarctions was uniformly low throughout. Our results also suggest that abnormal findings on cardiac stress testing do not correlate with risk of postoperative myocardial infarction. Future areas for quality improvement in the So Cal VOICe will focus on identifying drivers of these variations and developing and implementing strategies to standardize preoperative cardiac stress testing utilization in the Southern California region.

Acknowledgments

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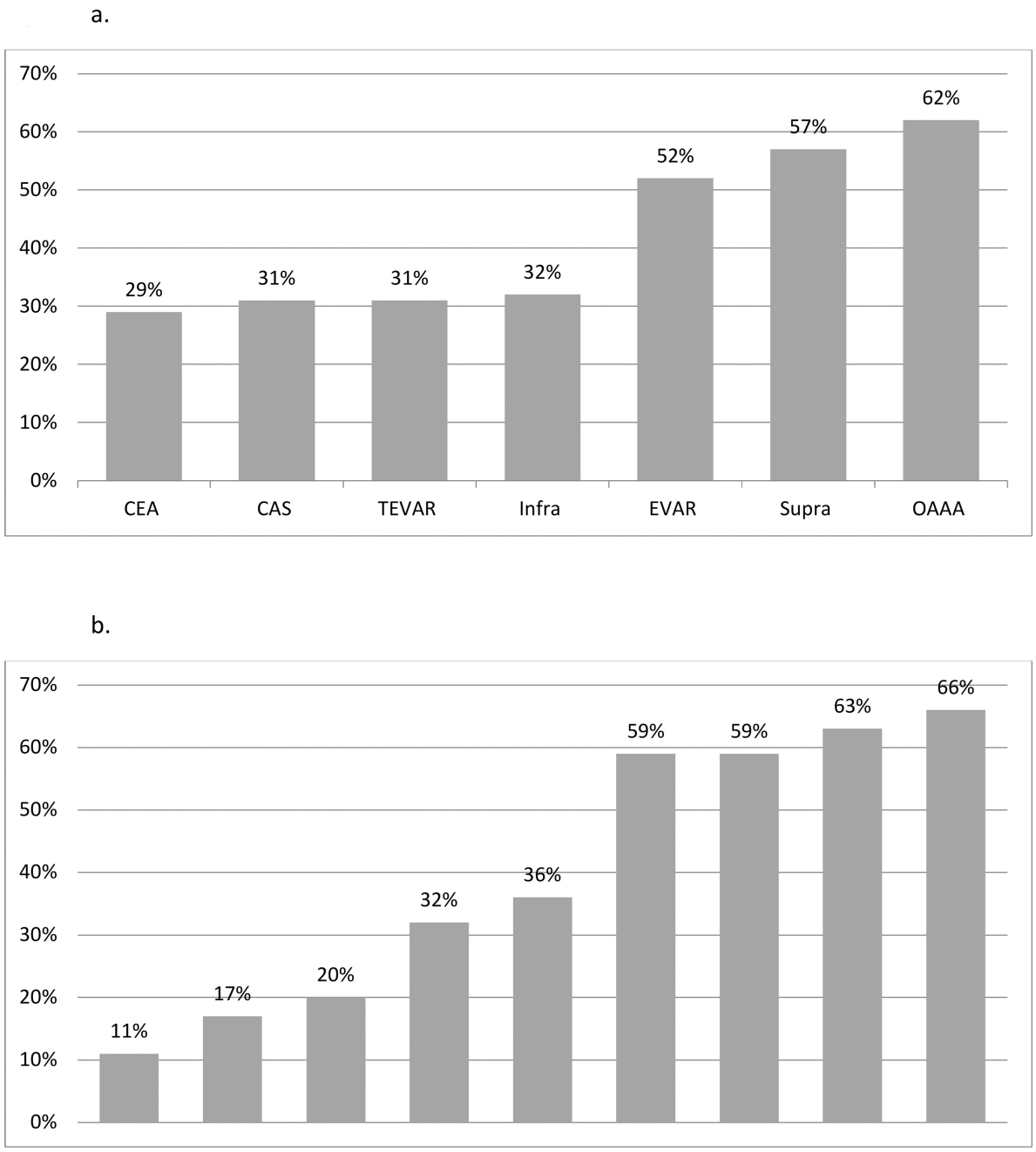


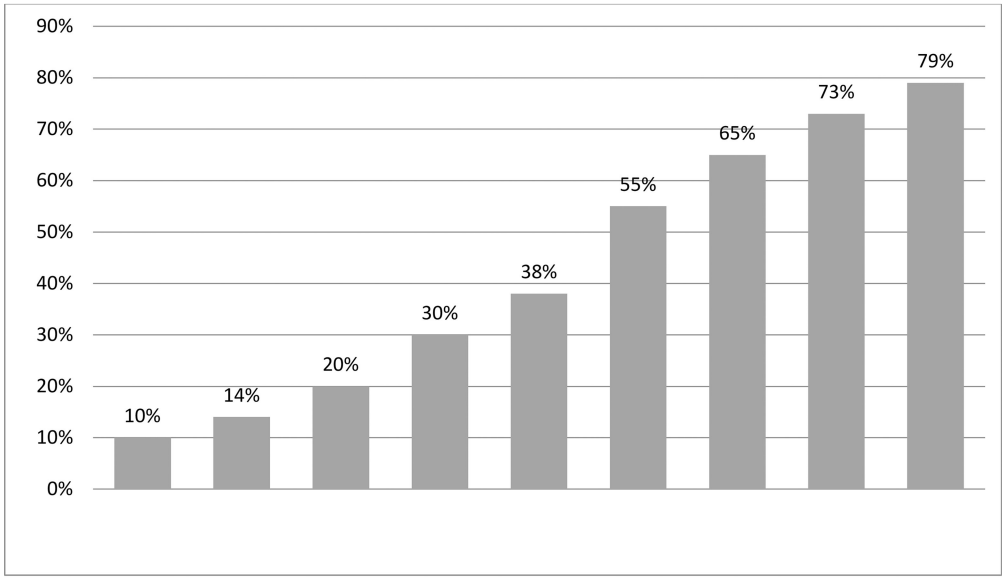
Figure 1. Stress test frequency

a. Across all registries

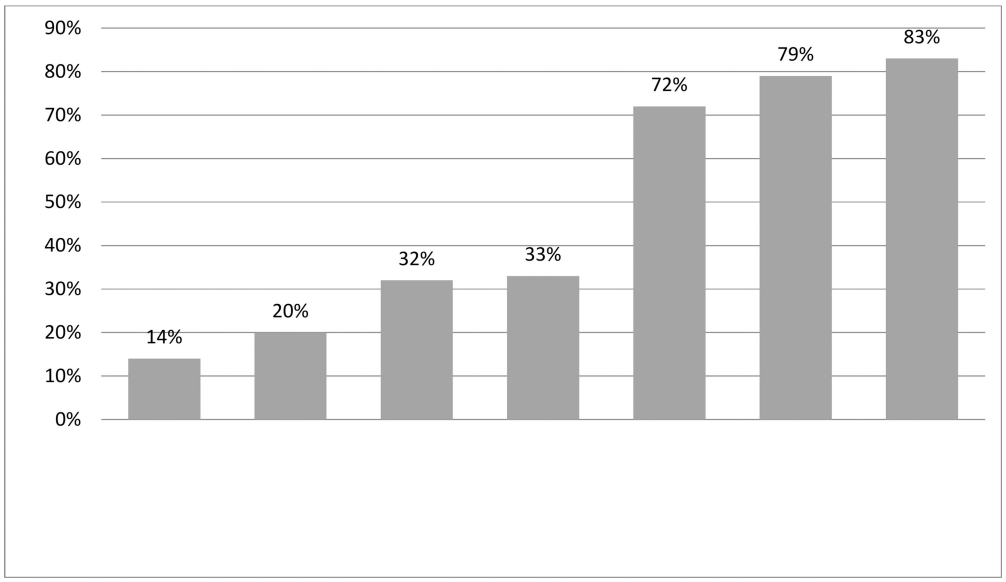
b. Across all centers*

*Only centers contributing at least 50 procedures are included in this graph.

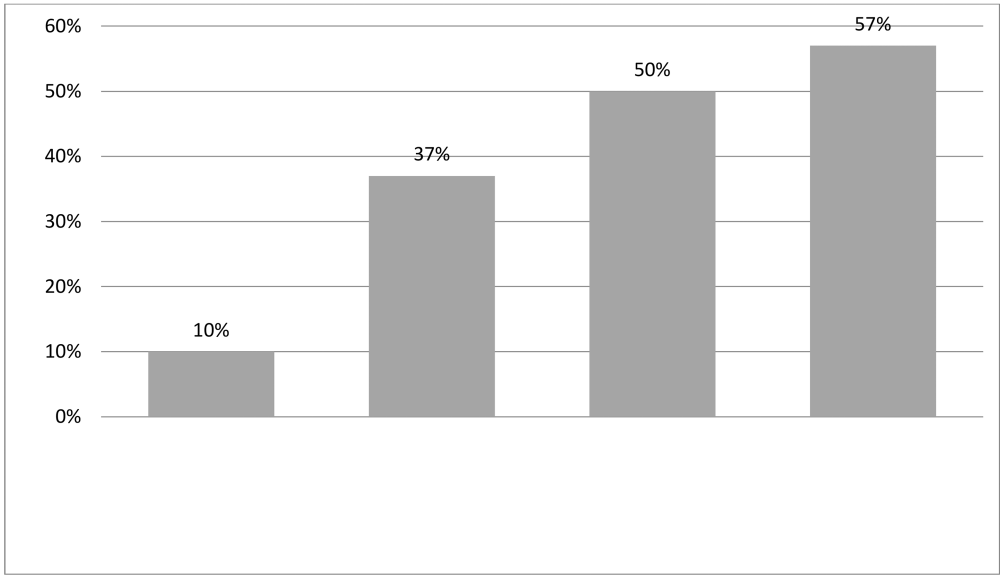
a.



b.



c.



d.

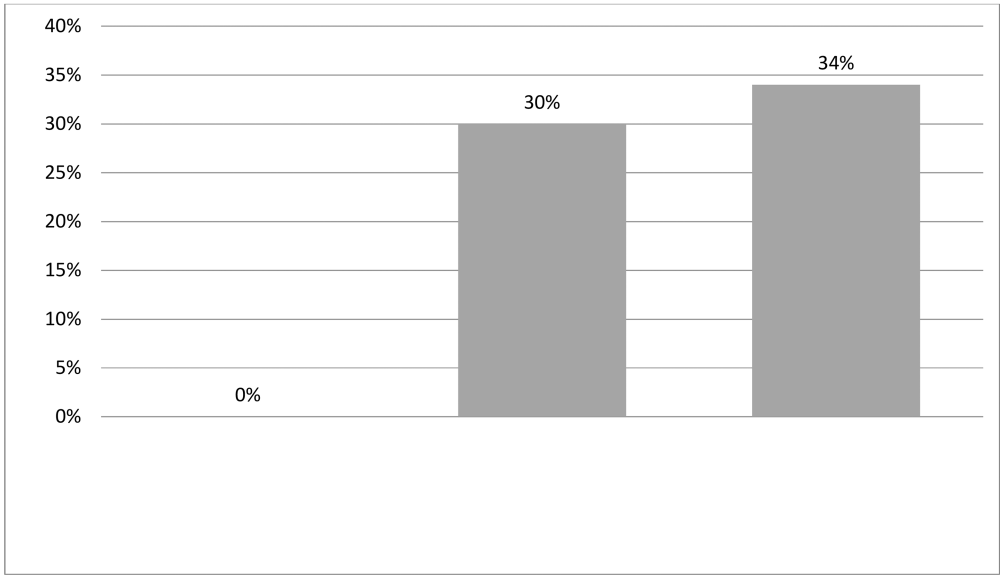


Figure 2. Stress test frequency by registry across centers

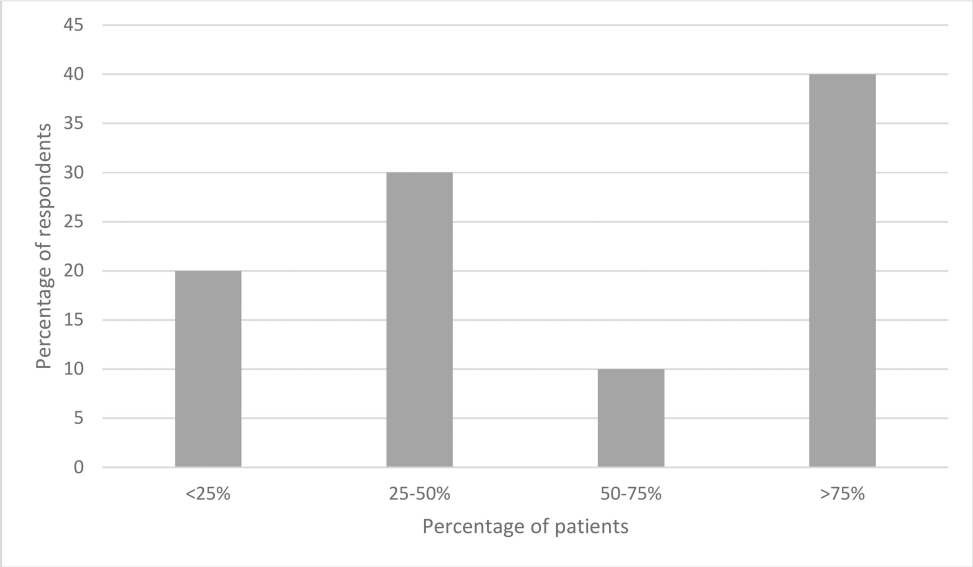
a. carotid endarterectomy

b. endovascular aneurysm repair

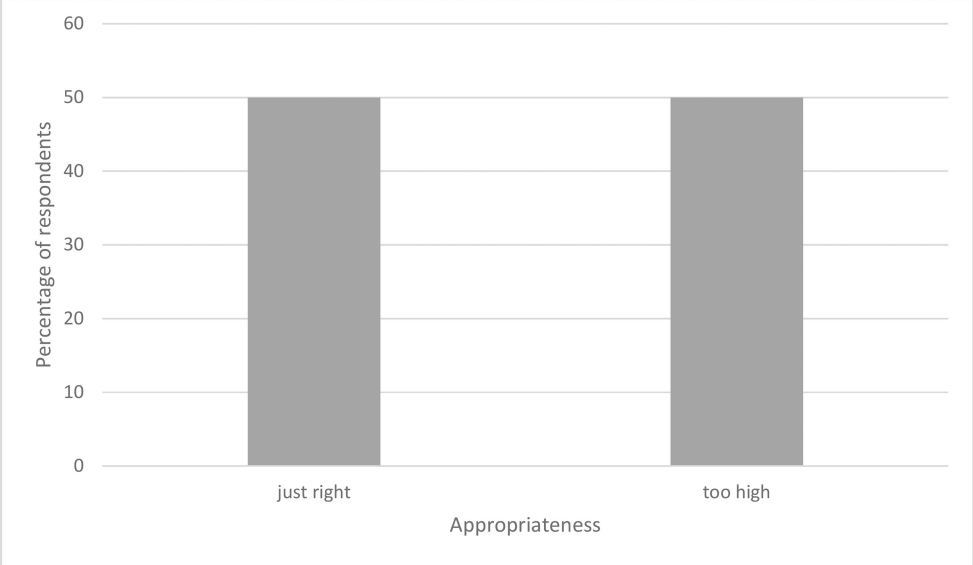
c. infrainguinal bypass

d. thoracic endovascular aneurysm repair

a.



b.



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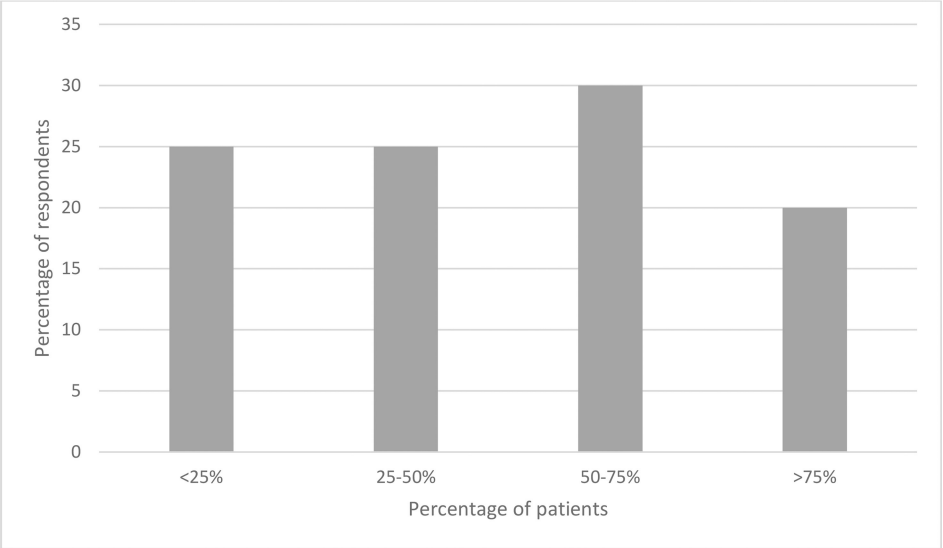
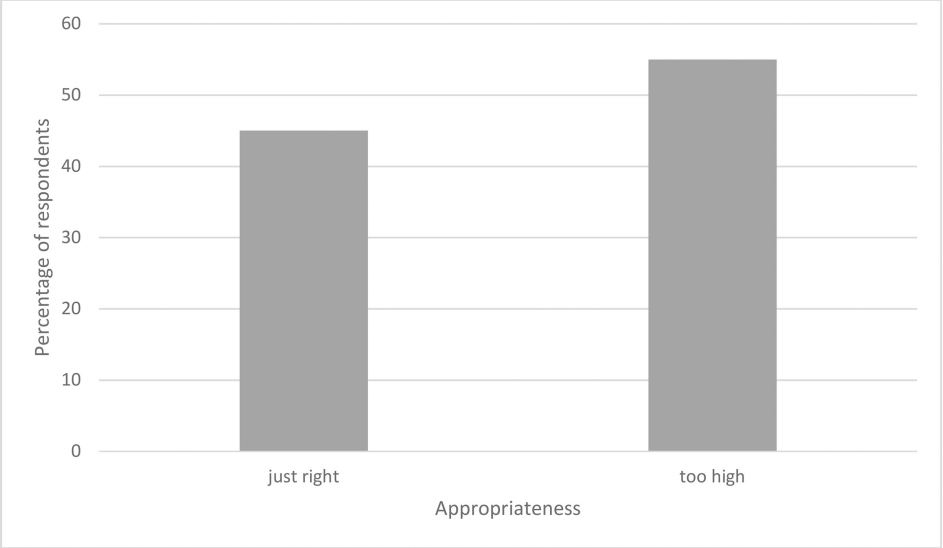
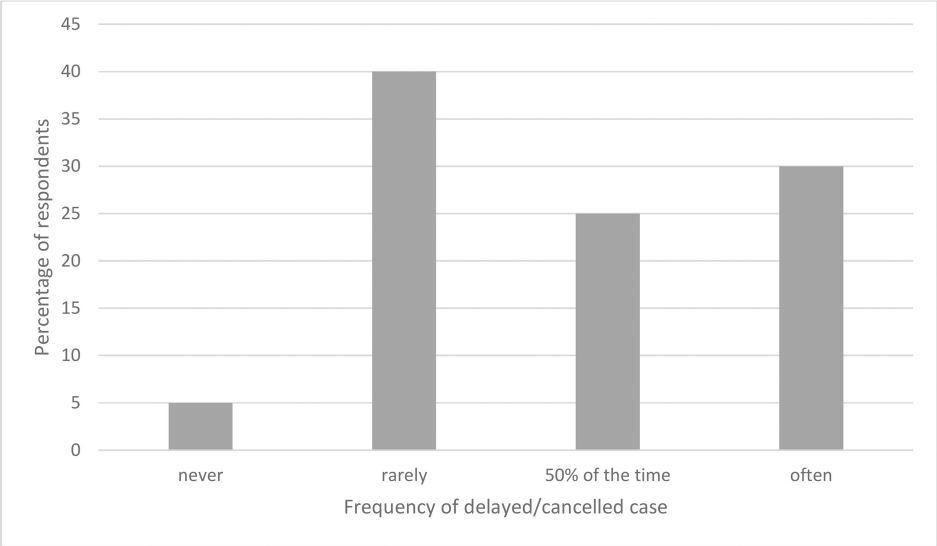


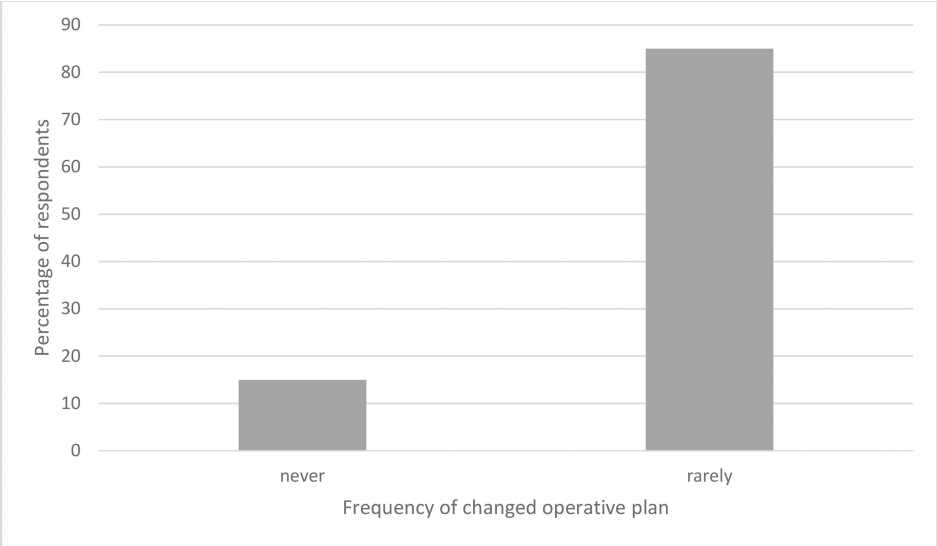
d.



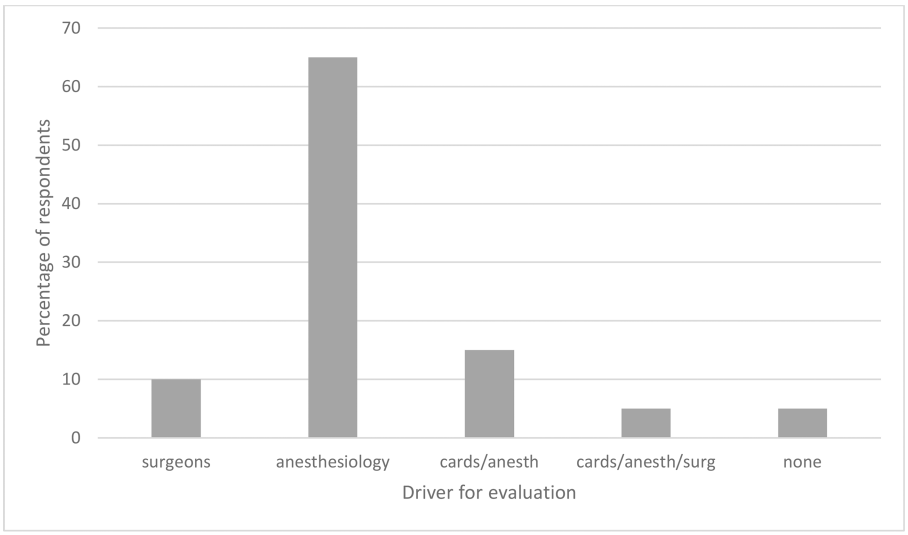
e.



f.

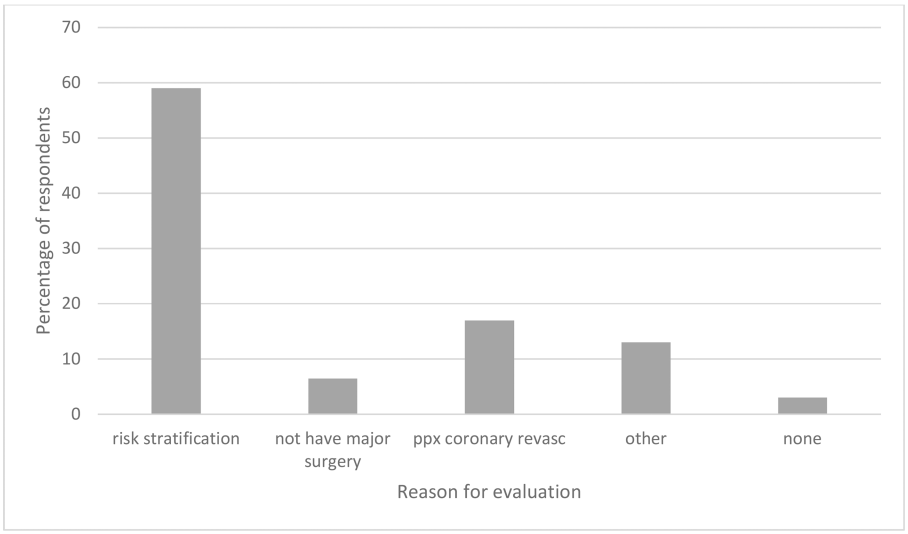


g.



cards= cardiology, anesth= anesthesiology, surg= surgeon

h.



ppx coronary revasc= prophylactic coronary revascularization

Figure 3. So Cal VOICe PCST practices survey results

a. Percentage of patients who undergo pre-operative resting echocardiogram

b. Appropriateness of resting echocardiogram usage

c. Percentage of patients who undergo PCST

d. Appropriateness of PCST

e. Frequency of delayed/cancelled cases due to PCST

f. Frequency of changed operative plans due to PCST results

g. Drivers for ordering of PCST

b. Reason for PCST

Table 1

Demographics by PCST

	Stress test n (%)	No stress test n (%)	P
N	667 (36)	1199 (64)	
Age (mean)	72.4	71.7	0.13
Males	464 (69)	761 (63)	0.008
Whites	559 (84)	1003 (84)	0.98
Smokers	473 (71)	801 (67)	0.09
Diabetes	190 (29)	364 (30)	0.40
Dialysis	24 (3.7)	28 (2.3)	0.21
Chronic Obstructive Pulmonary Disease	113 (17)	190 (16)	0.54

Table 2

Normal stress test, post-operative myocardial infarction by registry

Registry	normal stress test (%)[a]	Post- operative myocardial infarctions	Stress test in patients with MI[b]	Result of stress test[c]
CAS	24 (70)	1	Yes	Normal
CEA	176 (67)	0	-	-
EVAR	133 (87)	4	Yes for 2	Both normal
Infra	70 (83)	1	No	-
OAAA	36 (92)	1	Yes	Normal
Supra	43 (88)	1	Yes	Normal
TEVAR	44 (93)	4	Yes for 1	Abnormal

[a] % of all stress tests that were normal

[b] MI= post-operative myocardial infarction

[c] result of stress test when done in patient who had a post-operative myocardial infarction