# Statin Therapy in the Perioperative Period

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*Statins are frequently used as chronic therapy for reducing cardiovascular mortality and morbidity, but there has been less emphasis on the role of statins in the perioperative period. This review evaluates data regarding statin use in vascular and noncardiac surgery, the use of statins in combination with β-blockers in the perioperative period, perioperative statin use in patients already treated with statins, and the safety of statin therapy in the perioperative period. Current recommendations state that patients who are prescribed statins as chronic therapy should continue treatment in the perioperative period, but data suggest that there may be benefit from the use of perioperative statins in a wider population.*

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Optimizing perioperative care is important for reducing morbidity and mortality associated with surgery. A great deal of attention has been paid to the role of β-blockers in the perioperative period, with mixed results as to their efficacy.[1-5] This article reviews the currently available data to evaluate the utility of statin therapy at the time of surgery. Unanimity of opinion is lacking regarding the perioperative use of statins. There is a dearth of double-blind, prospective, randomized trials looking at the role of statins in the perioperative period, but there are several recent retrospective, observational studies that suggest that the use of these medications is beneficial in reducing untoward perioperative events (Table 1).[6-18] However, a review of 18 studies in 2006 concluded that there are inadequate data to recommend

**Table 1**
**Studies of Statin Therapy Effect on Clinical Endpoints in the Perioperative Period**

| Study | Design | Sample Size | Surgical Type | Primary Endpoint | OR or RR (95% CI) |
|---|---|---|---|---|---|
| Poldermans D et al[6] | Case-control | 2816 | Vascular | Death | 0.22 (0.10-0.47) |
| O'Neil-Callahan K et al[7] | Retrospective cohort | 1163 | Vascular | Death, cardiac complications | 0.56 (0.39-0.79) |
| Lindenauer PK et al[8] | Retrospective cohort | 780,591 | Major noncardiac | Mortality | 0.62 (0.58-0.67) |
| Durazzo AE et al[9] | Randomized controlled | 100 | Vascular | Cardiac death, ACS, stroke | 0.31 ($P$ = .031) |
| McGirt MJ et al[10] | Retrospective cohort | 1566 | Carotid endarterectomy | Stroke<br>Death | 0.29 (0.14-0.61)<br>0.14 (0.03-0.62) |
| Kennedy J et al[11] | Retrospective cohort | 3360 | Carotid endarterectomy | Symptomatic:<br>In-hospital mortality<br>In-hospital ischemic stroke, or death<br>Asymptomatic:<br>In-hospital mortality<br>In-hospital ischemic stroke, or death | <br>0.25 (0.07-0.90)<br>0.55 (0.32-0.95)<br><br>0.54 (0.13-2.24)<br>1.34 (0.61-2.93) |
| LaMuraglia G et al[12] | Retrospective | 2127 | Carotid endarterectomy | Early restenosis<br>Early failure<br>Late progression<br>Late failure | 0.619<br>0.466<br>0.280<br>0.176 |
| Noordzij P et al[13] | Retrospective case-control | 75,581 | Noncardiac, nonvascular surgery | Perioperative mortality | 0.40 (0.24-0.68) |
| Kertai M et al[14] | Retrospective | 570 | Abdominal aortic aneurysm repair | Perioperative mortality and MI | 0.31 (0.13-0.74) |
| Kertai M et al[15] | Retrospective | 519 | Abdominal aortic aneurysm repair | Long-term all cause mortality<br>Long-term CV mortality | 0.4 (0.3-0.5)<br>0.3 (0.2-0.6) |
| Dunkelgrun M et al[5] | Prospective, open-label | 1066 | Non-CV | Cardiac death and nonfatal MI 30 days postoperative | 0.65 (0.35-1.1)<br>$P$ = .17 |
| LeManach Y et al[17] | Retrospective | 491 | Vascular surgery | Myonecrosis | 0.38 (0.15-0.98) |

CI, confidence interval; CV, cardiovascular; MI, myocardial infarction; OR, odds ratio; RR, relative risk.

routine administration of statins to reduce perioperative cardiovascular risk.[19] The current American College of Cardiology/American Heart Association (ACC/AHA) Perioperative Guidelines only include a class I indication for perioperative statin therapy in patients taking statins before the planned surgery[20]; this comprises many patients, given that statin therapy is very effective in both the primary and secondary prevention of cardiac events.[21-26] There is a class IIa indication for administration of statins to patients undergoing vascular surgery (regardless of clinical risk factors), and a class IIb indication for the use of perioperative statins in patients with at least one clinical risk factor who are undergoing intermediate-risk procedures.

Statins are believed to work primarily by lowering low-density lipoprotein cholesterol levels. However, aside from their primary effect on lipids, statins have been shown in vitro to have pleiotropic effects (eg, reduction in vascular inflammation, plaque stabilization, improvement of endothelial function, and effects on thrombosis) that may also play a role in reducing the

incidence of cardiovascular events (Figure 1).[27-29]

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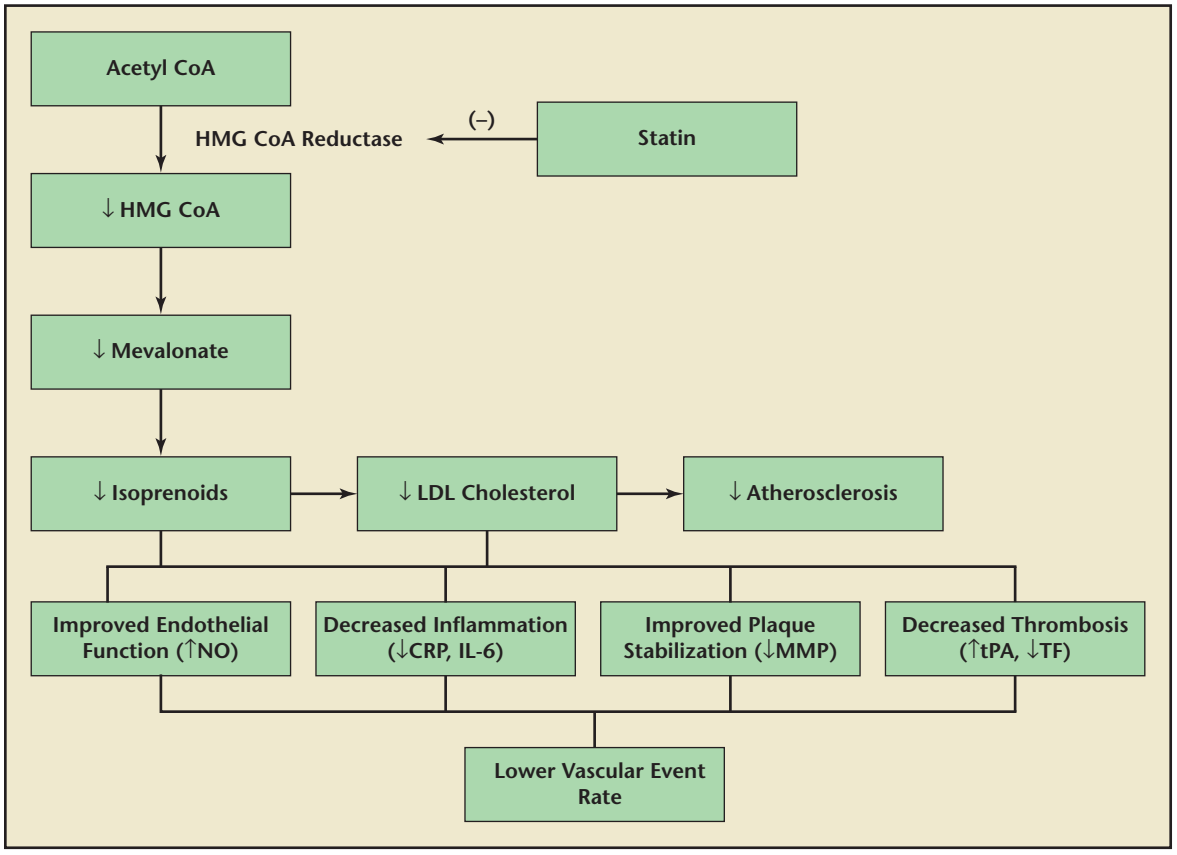
## Statin Use in Vascular Surgery and Noncardiac Surgery

Poldermans and colleagues[6] undertook a case-control study evaluating the association between statin use and perioperative death. Of 2816 patients who underwent major vascular surgery, 160 patients died during surgery or during the hospital stay. These 160 patients were selected as the "cases," and from the remaining patients 2 control subjects were selected for each case. Statins were used significantly less in the cases than in the controls, and the risk of perioperative mortality among statin users was reduced 4.5 times compared with nonusers, with an adjusted odds ratio (OR) of 0.22 (95% confidence interval [CI], 0.10-0.47). Medication use, including aspirin and β-blockers, was adjusted to ensure that there was no significant interaction between the use of the medication and statins with regard to perioperative mortality. Although this is an observational retrospective study, the results support an association between statin use and reduced perioperative mortality.

In a similar study, O'Neil-Callahan and coworkers[7] retrospectively evaluated patients who underwent noncardiac vascular surgery to assess if statin therapy was associated with decreased cardiac complications. Among 1163 hospitalizations in 997 patients, there were 157 complications of interest (death, acute myocardial infarction [MI], myocardial ischemia, acute congestive heart failure, ventricular tachyarrhythmias). Complications of

**Figure 1.** *Potential mechanism for statin-mediated effect on perioperative vascular events. CRP, C-reactive protein; HMG CoA, 3-hydroxy-3-methylglutaryl-coenzyme A; IL-6, interleukin 6; LDL, low-density lipoprotein; MMP, matrix metalloproteinase; NO, nitric oxide; TF, tissue factor; tPA, tissue plasminogen activator.*



interest occurred in 9.9% of the hospitalizations in which statins were given as compared with 16.5% of the hospitalizations in which statins were not given; this is an OR of 0.56 (95% CI, 0.39-0.79; $P = .0012$). Accounting for other factors, including the use of β-blockers, the protective benefits of statins remained unchanged. The authors concluded that 15 patients would need to be treated with statins to avoid one cardiac complication. Again taking into account the retrospective observational nature of the study, it suggests that statin use is associated with a significant reduction in the rate of complications in patients undergoing vascular surgery.

In a large retrospective cohort study, Lindenauer and associates[8] looked at the relationship between lipid-lowering therapy and in-hospital mortality following major noncardiac surgery. Of 780,591 patients who underwent major noncardiac surgery, 9.9% received lipid-lowering therapy, and 91% of patients receiving lipid-lowering therapy were given statin therapy. Each patient in the treated group was matched with up to 2 patients in the nontreated or late treated group. To be included in the lipid-lowering therapy group, patients had to have received such medication within the first 2 days of hospitalization. Otherwise, they were relegated to the nontreated or late treated group. Crude mortality was lower in the treatment group (2.13% vs 3.05%; $P < .001$), and when using matching by propensity score the treatment group mortality rate remained significantly lower (2.18% vs 3.15%; $P < .001$). The perioperative administration of lipid-lowering medications was associated with an adjusted OR of in-hospital mortality of 0.62 (95% CI, 0.58-0.67), with a number needed to treat of 85. As cardiac risk increased, the number needed to treat was reduced to 30 in the highest-risk group. In the lipid-lowering group there were 70,159 statin users; their in-hospital mortality rate was 2.09% and the unadjusted OR was 0.68 (95% CI, 0.64-0.72). This large observational study provides more evidence to suggest the benefit of statin use in the perioperative period.

Among the many retrospective studies evaluating statins in the perioperative period, Durazzo and colleagues[9] undertook a prospective, randomized, placebo-controlled, double-blind clinical trial. In this small study, 100 patients were randomly assigned to receive either 20 mg of atorvastatin or placebo once daily for 45 days (regardless of serum cholesterol levels). On average, 30 days after randomization (and not earlier than 2 weeks) noncardiac vascular surgery was performed, and the patients were followed over 6 months to evaluate for a primary endpoint of death from cardiac causes, nonfatal MI, unstable angina, and stroke; 50 patients were assigned to the atorvastatin group and 50 to the placebo group. The primary endpoint was observed in 17 patients: 4 in the atorvastatin group and 13 in the placebo group. This is an overall event rate of 26% in the placebo group compared with 8.0% in the atorvastatin group ($P = .031$). There was a significant decrease in the rate of cardiac events in the atorvastatin group compared with the placebo group ($P = .018$). Although this is a small study with a composite endpoint, it is a randomized, controlled trial and makes a strong case for treating patients with statins prior to vascular surgery.

## Statins in Carotid Endarterectomy

McGirt and associates[10] retrospectively evaluated patients undergoing carotid endarterectomy (CEA) to assess the association between statin use and perioperative mortality/stroke. CEA was performed on 1566 patients, 126 of whom underwent a combined CEA and coronary artery bypass grafting procedure. Of the patients undergoing a procedure, 657 (42%) were taking a statin. To qualify as a statin user, outpatients had to be taking the medicine for at least 1 week prior to surgery and inpatients needed to have statins listed on their admission medication lists. There were 21 (1.3%) perioperative deaths and 49 (3.1%) perioperative strokes. Univariate analysis revealed that statin use was associated with both a reduction in perioperative strokes and mortality: 1.2% versus 4.5% ($P < .01$) and 0.3% versus 2.1% ($P < .01$), respectively. In multivariate analysis (adjusting for comorbidities associated with stroke and perioperative mortality) statin use remained independently associated with a threefold reduction in the odds of perioperative stroke and sevenfold reduction in the odds of perioperative death. The ORs for stroke and death were 0.29 (0.14-0.61, $P < .05$) and 0.14 (0.03-0.62, $P < .05$), respectively. These data suggest that the use of statin therapy reduces the incidence of perioperative stroke and mortality in patients undergoing CEA.

In a retrospective study, Kennedy and coworkers[11] evaluated whether statin use before CEA was associated with a reduction in the rate of in-hospital adverse outcomes. Over 3000 patient charts were reviewed to compare the outcomes of patients on statins versus those not on statins. At the time of hospital admission, 815 of 2031 symptomatic patients and 665 of 1252 asymptomatic patients were treated with a statin. A reduction in in-hospital mortality and in-hospital ischemic stroke or death was

found in symptomatic patients who were using statins (adjusted OR 0.25 [95% CI, 0.07-0.90], 0.55 [95% CI, 0.32-0.95], respectively). This reduction was not noted in asymptomatic patients on statins (adjusted OR, in-hospital mortality 0.54 [95% CI, 0.13-2.24]; in-hospital ischemic stroke or death 1.34 [95% CI, 0.61-2.93]). Similar to the study by McGirt and associates,[10] this study suggests that there is a benefit from statin use prior to CEA, but found that the benefit was limited to patients with a symptomatic indication for CEA. Randomly controlled trials will need to be carried out for more definitive evaluation of this problem.

Another potential benefit of statin therapy in patients undergoing CEA was described by LaMuraglia and coauthors.[12] The authors retrospectively evaluated 2127 primary isolated CEAs in 1853 patients. They noted that patients taking statins had lower rates of early restenosis (OR 0.619; $P = .0043$), early failure (OR 0.466; $P = .012$), late progression (OR 0.280; $P < .0001$), and late failure (OR 0.176; $P < .0001$). Thus, statin therapy appears to have significant beneficial effects on both early and late outcomes after CEA.

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## Statins in Combination With β-Blockers

Several studies have looked at a combination of statins and β-blockers in patients undergoing surgery. Noordzij and colleagues[13] undertook a retrospective case-control study to assess if the use of statins and a β-blocker is associated with reduced perioperative mortality in noncardiac/nonvascular surgery. Of 75,581 patients who underwent surgery, 989 patients who died during the hospital stay were studied; 1879 matched control subjects were selected from the remaining patients. Statins and β-blockers were each associated with a 60% reduction in mortality, but there was no additional benefit seen from adding one type of medication to the other. The authors note, however, that few patients were on both medications and that a protective effect from dual therapy should not be excluded on the basis of this study.

In a second study involving statins and β-blockers, Kertai and coworkers[14] evaluated the combination of statin and a β-blocker on perioperative mortality and MI in patients undergoing abdominal aortic aneurysm (AAA) surgery. Among 570 patients who underwent AAA surgery, the composite endpoint was significantly lower in statin users compared with nonusers (3.7% vs 11.0%; crude OR 0.31; 95% CI, 0.13-0.74; $P = .01$). Patients using statins had a threefold reduced risk of the composite endpoint when enrolled in a univariate analysis, and a fourfold reduction with multivariate analysis. The association between statin use and reduced incidence of MI and perioperative mortality remained significant after correcting for other covariates (OR 0.24; 95% CI, 0.10-0.70; $P = .01$). The combination of statins and β-blockers appeared to offer a protective benefit, especially in those patients with more risk factors.

Dunkelgrun and associates[5] examined the effectiveness of both β-blockers and statins in intermediate-risk patients undergoing noncardiovascular surgery in a prospective, open-label trial. The primary endpoint was a composite of cardiac death and nonfatal MI 30 days after surgery. A total of 1066 patients were randomized: 264 to bisoprolol therapy, 265 to fluvastatin therapy, 269 to combination therapy, and 268 to double control. The patients who received the most benefit were those who received bisoprolol. Interestingly, there did not appear to be any heterogeneity in the benefit of bisoprolol between patients randomized to fluvastatin versus fluvastatin control ($P = .26$). In patients who received fluvastatin versus those not receiving fluvastatin, there was a nonsignificant reduction in the incidence of the primary endpoint (OR 0.65; 95% CI, 0.35-1.1; $P = .17$). The authors postulate that this may be due to the fact that the study was terminated early and lacked statistical power to reveal clinically important differences. Another potential reason may be secondary to treatment bias, as this was an open-label design with lack of blinding. It will be interesting to see if these results are replicable with larger randomized, controlled trials.

## Long-Term Treatment With Statins Postoperatively

Once the issue of optimal perioperative management is addressed, further questions arise, such as whether there are benefits for continued use of statins postoperatively. Kertai and coworkers[15] addressed this question in a study based on the patients described above. Among 519 patients who survived AAA surgery beyond 30 days, 510 were followed for a median of 4.7 years. These patients were evaluated for the use of statins as well as for clinical risk factors. Among the 205 patients (40%) who died during follow-up, 140 deaths were due to cardiovascular causes. The incidence of all-cause mortality and cardiovascular mortality were both significantly lower in statin

users than in patients not taking statins: 18% versus 50% ($P < .001$) and 11% versus 34% ($P < .001$), respectively. Taking into account β-blocker use and clinical risk factors, statin use continued to impart significant mortality benefits. Statin users had significantly improved survival, with a 2.5-fold reduction in the risk of all-cause mortality (hazard ratio [HR] 0.4; 95% CI, 0.3-0.5) and a > threefold reduction in the risk of cardiovascular mortality (HR 0.3; 95% CI, 0.2-0.6). The data suggest that long-term use of statins after successful AAA repair is associated with improved mortality.

### Perioperative Statin Use in Patients Already Receiving Statins

Schouten and colleagues[16] examined whether patients who are already receiving a statin should continue to be treated during the perioperative period. They studied 298 patients receiving long-term statin therapy who underwent elective major vascular surgery. Long-term statin therapy was defined as use at the time of the first preoperative visit. Endpoints for the study were postoperative troponin release, nonfatal MI, cardiovascular death < 30 days after surgery, and a combination of nonfatal MI and cardiovascular death < 30 days after surgery. Statin therapy was interrupted during the perioperative period in 70 patients, with a mean interruption time of 3 days. In univariate analysis, patients who continued statin therapy had significantly decreased rates of myocardial ischemia, MI, cardiovascular death, and the combination of cardiovascular death and nonfatal MI: 16.7% versus 60%, 5.7% versus 30.0%, 1.8% versus 7.1%, and 5.7% versus 31.4%, respectively. When applying multivariate analysis, statin interruption remained an independent predictor of adverse cardiac outcome. This study suggests that statin withdrawal during the perioperative period is associated with an increased risk of cardiac events. Although it was not a double-blind, prospective randomized trial, this study should encourage physicians to give thought to discontinuing statins in those patients who are already receiving them.

In a similar study, Le Manach and coworkers[17] examined cardiac outcome in patients who continued statin therapy after major vascular surgery compared with those who discontinued statin therapy. This retrospective analysis included patients on chronic statin therapy who underwent nonemergent infrarenal aortic reconstructive surgery or endoprosthetic procedures. A total of 491 patients were included in the discontinuation group, in which the median delay for resuming statin therapy postoperatively was 4 days, and 178 patients were included in the continuation group, in which the median delay for resuming statin therapy postoperatively was 1 day. After adjusting for propensity score, the authors found a significant risk for myonecrosis in the discontinuation group (OR 2.1; 95% CI, 1.1-3.8; $P < .03$). The continuation group, however, was associated with a significant risk reduction for myonecrosis (OR 0.38; 95% CI, 0.15-0.98; $P < .04$). Patients in whom statin therapy was resumed more than 4 days postoperatively had a 2.9-fold increase in the postoperative rate of myonecrosis. Although this retrospective study has some limitations, it does suggest that postoperative withdrawal of statins from patients on chronic statin therapy who are undergoing infrarenal aortic surgical or percutaneous treatment is associated with a higher risk of cardiac morbidity.

### Safety of Statins in the Perioperative Period

A major question that should be answered before starting patients on a statin prior to surgery is whether therapy is safe in the perioperative period. One of the major adverse events associated with statin use is myopathy. Schouten and colleagues[18] evaluated the influence of statin use on postoperative myopathy in patients undergoing major noncardiac surgery. Patients scheduled to undergo major elective vascular surgery were evaluated for total serum cholesterol levels; if levels were elevated (> 5.5 mmol/L) patients were treated with statins. Patients already taking a statin remained on it. The patients were evaluated for muscle complaints and elevation in creatinine phosphokinase (CPK) levels, creatine kinase-MB, aspartate transaminase, alanine aminotransaminase, and troponin T levels preoperatively, and at days 1, 3, and 7 after surgery. Patients who were on statin therapy had a significantly higher CPK level at hospital admission; however, CPK levels did not exceed the upper limit of normal and there were no muscle complaints. During the perioperative period no patient reported muscle weakness or pain. Median maximum CPK level was 301 U/L (range 16-13,377) in statin users and 192 U/L (range 8-30,390) in patients not

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receiving statins. When corrected for length of surgery, cardiac risk factors, and risk factors for myopathy, the difference between users and nonusers was not significant ($P = .142$).

## Conclusions

In the most recent ACC/AHA Perioperative Guidelines, there is a class IA recommendation for perioperative statin therapy in patients who were prescribed the medication before surgery and a class IIA recommendation for patients undergoing vascular surgery. Several retrospective studies suggest that there is a benefit from use of statins in a wider population undergoing surgery, as evidenced by a reduction in cardiovascular events and death, raising the question as to whether perioperative statins should be used more frequently. Another question that needs to be addressed is whether patients undergoing surgery (particularly vascular surgery) who have lipid levels within guideline limits for their underlying condition would benefit from a pleiotropic effect of statin therapy. Prospective randomized trials will need to be undertaken to obtain more definitive information. ■

### References


1. Devereaux PJ, Beattie WS, Choi PT, et al. How strong is the evidence for the use of perioperative blockers in non-cardiac surgery? Systematic review and meta-analysis of randomised controlled trials. *BMJ*. 2005;331:313-321.
2. Fleischmann KE, Beckman JA, Buller CE, et al. 2009 ACCF/AHA focused update on perioperative beta blockade: a report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. *Circulation*. 2009; 120:2123-2151.
3. Chopra V, Plaisance B, Cavusoglu E, et al. Perioperative beta-blockers for major noncardiac surgery: primum non nocere. *Am J Med*. 2009;122:222-229.
4. Lindenauer PK, Pekow P, Wang K, et al. Perioperative beta-blocker therapy and mortality after major noncardiac surgery. *N Engl J Med*. 2005;353:349-361.
5. Dunkelgrun M, Boersma E, Schouten O, et al. Bisoprolol and fluvastatin for the reduction of perioperative cardiac mortality and myocardial infarction in intermediate-risk patients undergoing noncardiovascular surgery: a randomized controlled trial (DECREASE-IV). *Ann Surg*. 2009;249:921-926.
6. Poldermans D, Bax JJ, Kertai MD, et al. Statins are associated with a reduced incidence of perioperative mortality in patients undergoing major noncardiac vascular surgery. *Circulation*. 2003;107:1848-1851.
7. O'Neil-Callahan K, Katsimaglis G, Tepper MR, et al. Statins decrease perioperative cardiac complications in patients undergoing noncardiac vascular surgery: the Statins for Risk Reduction in Surgery (StaRRS) study. *J Am Coll Cardiol*. 2005;45:336-342.
8. Lindenauer PK, Pekow P, Wang K, et al. Lipid lowering therapy and in-hospital mortality following major noncardiac surgery. *JAMA*. 2004;291:2092-2099.
9. Durazzo AE, Machado FS, Ikeoka DT, et al. Reduction in cardiovascular events after vascular surgery with atorvastatin: a randomized trial. *J Vasc Surg*. 2004;39:967-975; discussion 975-976.
10. McGirt MJ, Perler BA, Brooke BS, et al. 3-Hydroxy-3-methylglutaryl coenzyme A reductase inhibitors reduce the risk of perioperative stroke and mortality after carotid endarterectomy. *J Vasc Surg*. 2005;42:829-836.
11. Kennedy J, Quan H, Buchan AM, et al. Statins are associated with better outcomes after carotid endarterectomy in symptomatic patients. *Stroke*. 2005;36:2072-2076.
12. LaMuraglia GM, Stoner MC, Brewster DC, et al. Determinants of carotid endarterectomy anatomic durability: effects of serum lipids and lipid-lowering drugs. *J Vasc Surg*. 2005;41:762-768.
13. Noordzij PG, Polermans D, Schouten O, et al. Beta-blockers and statins are individually associated with reduced mortality in patients undergoing noncardiac, nonvascular surgery. *Coron Artery Dis*. 2007;18:67-72.
14. Kertai MD, Boersma E, Westerhout CM, et al. A combination of statins and beta-blockers is independently associated with a reduction in the incidence of perioperative mortality and nonfatal myocardial infarction in patients undergoing abdominal aortic aneurysm surgery. *Eur J Vasc Endovasc Surg*. 2004;28:343-352.
15. Kertai MD, Boersma E, Westerhout CM, et al. Association between long-term statin use and mortality after successful abdominal aortic aneurysm surgery. *Am J Med*. 2004;116:96-103.
16. Schouten O, Hoeks SE, Welten GM, et al. Effect of statin withdrawal on frequency of cardiac events after vascular surgery. *Am J Cardiol*. 2007;100:316-320.
17. Le Manach Y, Godet G, Coriat P, et al. The impact of postoperative discontinuation or continuation of chronic statin therapy on cardiac outcome after major vascular surgery. *Anesth Analg*. 2007;104:1326-1333.
18. Schouten O, Kertai MD, Bax JJ, et al. Safety of perioperative statin use in high-risk patients undergoing major vascular surgery. *Am J Cardiol*. 2005;95:658-660.
19. Kapoor AS, Kanji H, Buckingham J, et al. Strength of evidence for perioperative use of statins to reduce cardiovascular risk: systemic review of controlled studies. *BMJ*. 2006; 333:1149.
20. Fleisher LA, Beckman JA, Brown KA, et al. ACC/AHA 2007 Guidelines on Perioperative Cardiovascular Evaluation and Care for Noncardiac Surgery: Executive Summary: A Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Writing Committee to Revise the 2002 Guidelines on Perioperative Cardiovascular Evaluation for Noncardiac Surgery) Developed in Collaboration With the American Society of Echocardiography, American Society of Nuclear Cardiology, Heart Rhythm Society, Society of Cardiovascular Anesthesiologists, Society for Cardiovascular Angiography and Interventions, Society for Vascular Medicine and Biology, and Society for Vascular Surgery. *J Am Coll Cardiol*. 2007;50:1707-1732.
21. National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III). Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III) final report. *Circulation*. 2002;106: 3143-3421.
22. Heart Protection Study Collaborative Group. The MRC/BHF Heart Protection Study of cholesterol lowering with simvastatin in 20,536 high-risk individuals: a randomised placebo-controlled trial. *Lancet*. 2002;360:7-22.


## Main Points

- There is a class I indication for perioperative statin therapy for patients taking statins before surgery.
- There is a class IIA indication for statin therapy in patients undergoing vascular surgery.
- Statin therapy is safe in the perioperative period.
- Statin discontinuation during the perioperative period in patients undergoing vascular surgery may be associated with an increased risk for cardiac events.

23. Shepherd J, Cobbe SM, Ford I, et al. Prevention of coronary heart disease with pravastatin in men with hypercholesterolemia. West of Scotland Coronary Prevention Study Group. *N Engl J Med*. 1995;333:1301-1307.
24. Sacks FM, Pfeffer MA, Moyer LA, et al. The effect of pravastatin on coronary events after myocardial infarction in patients with average cholesterol levels. Cholesterol and Recurrent Events Trial investigators. *N Engl J Med*. 1996;335:1001-1009.
25. Downs JR, Clearfield M, Weis S, et al. Primary prevention of acute coronary events with lovastatin in men and women with average cholesterol levels: results of AFCAPS/TexCAPS. Air Force/Texas Coronary Atherosclerosis Prevention Study. *JAMA*. 1998;279:1615-1622.
26. Scandinavian Simvastatin Survival Study Group. Randomised trial of cholesterol lowering in 4444 patients with coronary heart disease: the Scandinavian Simvastatin Survival Study (4S). *Lancet*. 1994;344:1383-1389.
27. Davignon J. Beneficial cardiovascular pleiotropic effects of statins. *Circulation*. 2004;109:III-39-III-43.
28. Ray KK, Cannon CP. The potential relevance of the multiple lipid-independent (pleiotropic) effects of statins in the management of acute coronary syndromes. *J Am Coll Cardiol*. 2005;46:1425-1433.
29. Cubeddu LX, Seamon MJ. Statin withdrawal: clinical implications and molecular mechanisms. *Pharmacotherapy*. 2006;26:1288-1296.