Preoperative statin therapy is associated with improved outcomes and resource utilization in patients undergoing aortic aneurysm repair

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Introduction: **This study hypothesized that preoperative statin therapy would have a protective effect on patients undergoing elective abdominal aortic aneurysm (AAA) repair and that the risk-reduction effect of these agents would result in a reduction in subsequent total hospital costs.**

Methods: **All patients who underwent an elective endovascular AAA repair (EVAR) or open AAA repair (OAR) between 2004 and 2007 were retrospectively reviewed. Clinical end points included postoperative days, length of hospital stay, postoperative complications (myocardial infarction, stroke, renal failure, hemorrhage, pneumonia, urinary tract infection, wound infection), and 30-day mortality. The financial end point was total hospital cost associated with the procedure.**

Results: **We identified 401 patients, consisting of 173 EVAR patients (43%) and 228 OAR (57%). Despite a higher Society for Vascular Surgery risk score, the EVAR statin cohort had significantly reduced postoperative days (1.9 ± 0.2 vs 2.3 ± 0.3, $P < .05$) and hospital length of stay (2.3 ± 0.3 vs 2.8 ± 0.4, $P < .05$) compared with the nonstatin EVAR cohort. Postoperative complications (4.4% vs 14.7%, $P < .05$) and the mortality rate (0.0% vs 5.9%, $P < .05$) were significantly decreased in the OAR statin cohort compared with the nonstatin OAR cohort and trended to be decreased in the EVAR statin group. Statin therapy translated into a lower total cost per patient of $3,205 for EVAR and $3,792 for OAR ($P < .05$).**

Conclusion: **With respect to both clinical outcome measures and subsequent resource utilization, statin therapy is associated with a beneficial effect in patients undergoing elective AAA repair. These data suggest that preoperative statin therapy should be an integral part of the risk optimization for patients undergoing AAA repair. (J Vasc Surg 2010;51:1390-6.)**

Total health care spending, which consumed approximately 8% of the 1975 United States economy, currently accounts for 16% of the gross domestic product and the share estimate is projected to reach nearly 20% by 2016. Publically financed Medicare and Medicaid spending is predicted to encompass 5.9% of the gross domestic product by 2017 and up to 20% by 2050.[1] Within this context, care-process improvement becomes an avenue for physician-driven health care reform. Specifically, careful case selection, patient optimization, meticulous surgical technique, and proper implementation of care pathways will yield better clinical outcomes, which in turn will improve resource utilization.

With this in mind, we reviewed our contemporary experience with elective open and endovascular treatment of abdominal aortic aneurysm (AAA) disease to investigating the protective role of preoperative statin therapy in patients undergoing elective AAA repair. Clinical and financial data were assessed to test our hypothesis that preoperative statins have beneficial effects in elective AAA repair that improve clinical outcomes and result in a decrease in costs and in improvements in hospital bed resource utilization.

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METHODS

This study was approved by the University and Medical Center Institutional Review Board of East Carolina University.

Patient selection and data collection. A retrospective computerized database was used to identify all patients with infrarenal AAAs who had undergone elective, nonruptured, open (OAR) or endovascular repair (EVAR) from July 2004 to July 2007. Patients were identified using the hospitals' billing database using appropriate Common Procedural Terminology (CPT) codes (OAR 35081, 35102; EVAR 34800-34826). The operative and clinical notes were reviewed, and nonelective cases were excluded. The decision to use OAR or EVAR was based on clinical evaluation, anatomic factors, and the attending surgeon's preference.

Preoperative, procedural, and outcome variables were collected from the computerized patient care records. Basic demographic data were recorded, omitting patient identifying information. Preoperative computed tomography images were reviewed to determine the size of the AAA, using the axial images, measuring the maximal minor axis adventitial-to-adventitial distance of the infrarenal aorta. Patients who presented with a complaint of abdominal or back pain

and a tender, pulsatile abdominal mass on physical examination were considered symptomatic.

Patient comorbidities were defined as:

- diabetes mellitus: medical treatment of diabetes with insulin, oral hypoglycemic agents, dietary care, or any combination thereof;
- hypertension: elevated blood pressure (>140/90 mm Hg) at the time of the initial evaluation or medical treatment of hypertension;
- hypercholesterolemia: medical treatment of dyslipidemia or total cholesterol >200 mg/dL;
- smoking/tobacco use: recorded as both lifetime tobacco use (history) and tobacco use at the time of operation (current);
- coronary artery disease: medical therapy for coronary vascular disease, anatomic diagnosis by axial imaging or catheterization, or by prior coronary revascularization;
- renal insufficiency: serum creatinine >1.5 mg/dL;
- end-stage renal disease: renal failure requiring continuing renal replacement therapy;
- chronic obstructive pulmonary disease (COPD): prior diagnosis of obstructive pulmonary process or ongoing medical therapy for such; and
- Society for Vascular Surgery (SVS)/American Association for Vascular Surgery (AAVS) risk score: based on the comorbid profiles, patients were assigned a risk score as described by Chaikof et al.[2]

Perioperative medical management (medication at the time of outpatient referral) was noted with respect to the following agents:

- antiplatelet therapy: aspirin or clopidogrel (Plavix, Sanofi-Aventis, Bridgewater, NJ);
- statin therapy: use of any 3-hydroxy-3-methyl-glutaryl-coenzyme A reductase inhibitor or combination agent;
- β-blocker: use of a β-adrenergic receptor antagonist or combination agent, regardless of selectivity;
- angiotensin blockade: an angiotensin-converting enzyme inhibitor (ACEI) or angiotensin receptor blocker (ARB).

OAR procedures. All OAR procedures took place in a cardiovascular operating room with the patient under a general anesthetic and an epidural catheter for postoperative analgesia. The aortic replacement took place by a transperitoneal inframesocolic aortic exposure or a left retroperitoneal exposure, at the discretion of the attending surgeon. Before aortic clamp placement, patients were systemically heparinized, and appropriate pharmacologic afterload reduction was undertaken. Protamine sulfate was given to reverse systemic heparinization, and a combination of autologous and donor blood products were used as appropriate.

Patients were admitted to an intensive care unit and transferred to an intermediate care unit typically ≤24 hours. During their stay, patients were cared for using a standard postoperative care pathway, which included the use of aspirin and β-blockers for cardiovascular risk reduction, regardless of preoperative use.

EVAR procedures. Preoperative planning used computed tomography scan with administration of intravenous iodinated contrast. Device selection was the decision of the attending surgeon. General anesthesia was used for most procedures. After dissection of the femoral arteries, the patient was systemically heparinized, and the stent graft was deployed according to the device-specific indications for use. After completion, protamine sulfate was administered, and a combination of autologous and donor blood products were used as needed.

Patients were admitted to an intermediate care unit, and a standard care pathway was instituted, which included the use of postoperative aspirin and β-blockers, regardless of preoperative use.

Outcomes. The following initial hospitalization outcomes variables were recorded for each patient:

- death: 30-day all-cause mortality (or inpatient mortality if length of stay >30 days);
- myocardial infarction: electrocardiographic or biomarker-positive sign of myocardial injury;
- renal failure: use of renal replacement therapy in patients not already requiring dialysis;
- stroke: central neurologic deficit lasting >24 hours;
- pneumonia: radiographic findings of pneumonia and antibiotic course of treatment;
- urinary tract infection: urinalysis or urine culture demonstrating a bacterial infection and antibiotic course of treatment;
- wound complication: any wound issue including seroma, cellulitis with antibiotic treatment, wound infection requiring incision and drainage, or wound dehiscence;
- estimated blood loss from anesthesia record;
- length of stay: total number of hospital days associated with the index case;
- postoperative stay: total number of hospital days after the index case; and
- total cost (in US dollars): summation of direct and indirect hospital costs associated with the admission, including any secondary procedures or complication-related expenses. Cost data were obtained from an institutional inpatient billing database and were derived from accepted standard methodology for hospital surgical service line-cost determinations.

Statistical analysis. The study population was stratified by operative procedure, and univariate statistical methods (t test or χ^2 analysis) were used to examine differences in preoperative variables and postoperative outcomes. A multivariate (logistic regression) analysis was used to analyze the categoric variables associated with the occurrence of any of the listed complications. Variables with a value of $P < .10$ were considered candidates for this model. To examine the protective effect of preoperative statin therapy, patients were stratified by treatment modality and statin use, and univariate techniques were used to examine the