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Predictors of compliance with surveillance after endovascular aneurysm repair and comparative survival outcomes

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Objective: **Although imaging surveillance is mandatory for all patients after endovascular aneurysm repair (EVAR), many patients are not compliant with follow-up. We sought to determine predictors of compliance with EVAR surveillance and to examine how compliance with current surveillance protocols correlates with survival.**

Methods: **We analyzed 188 patients who underwent EVAR at our institution for infrarenal abdominal aortic aneurysms (AAAs) between 2001 and 2011. The primary end point was compliance with post-EVAR surveillance recommendations. Univariate analysis included patient demographics and socioeconomic information, AAA characteristics, EVAR hospital course variables, late complications and secondary interventions, length of follow-up, smoking status, family history of AAA, driving distances, primary care providers, and medical comorbidities. Mortality was determined by the Social Security Death Index. Multinomial logistic regressions were fit to identify independent predictors of compliance. Survival plots were generated with the Kaplan-Meier method and compared with the log-rank test. Univariate and multivariate Cox regression analysis was used to determine effect of compliance on survival after adjusting for confounders.**

Results: **Of 188 patients, 89 (47.3%) were 100% compliant with follow-up visits and imaging, 21 (11.1%) were moderately compliant by missing appointments, and 78 (41.4%) were lost to follow-up completely. Overall median age was 74 years, and 81.9% of patients were male. Late complications occurred in 77 patients (40.9%), secondary interventions were performed in 32 patients (17%), and 5-year mortality was 21.2%. Mean follow-up interval was >40 months for 100% compliant and moderately compliant patients and <20 months for those lost to follow-up ($P < .0001$). In adjusted analysis, late complications (odds ratio [OR], 2.71; 95% confidence interval [CI], 1.32-5.55; $P = .007$), absence of social work consultation (OR, 2.43; 95% CI, 1.12-5.27; $P = .024$), and family history of AAA (OR, 2.67; 95% CI, 1.06-6.75; $P = .037$) were associated with 100% compliance, whereas shorter driving distances ($P = .051$) and shorter hospital stay ($P = .056$) approached significance. Transient ischemic attack or stroke (OR, 3.59; 95% CI, 1.18-10.91; $P = .024$) was the only variable independently associated with moderate compliance. Compared with patients lost to follow-up, 100% compliant patients had worse survival (log-rank test, $P = .033$), whereas moderately compliant patients' survival was not significantly different (log-rank test, $P = .149$). In adjusted Cox regression analysis, 100% compliant patients had decreased survival duration (rate ratio, 2.67; 95% CI, 1.18-6.06; $P = .018$) compared with those lost to follow-up.**

Conclusions: **Follow-up surveillance is incomplete for more than half of patients who undergo EVAR at our institution, and patient compliance can be predicted by covariates mentioned before. Compliance with current surveillance regimens does not confer a survival benefit. Further research individualizing surveillance protocols based on risk level of late complications and noncompliance and prospective studies examining resulting survival benefits of compliance are warranted. (J Vasc Surg 2015;62:27-35.)**

Endovascular aneurysm repair (EVAR) has progressively replaced open aneurysm repair for the treatment of infrarenal abdominal aortic aneurysms (AAAs) since its introduction two decades ago because of reduced operative morbidity, shorter intensive care unit (ICU) and hospital length of stay, and lower perioperative mortality rates.[1-4] Despite its increasing popularity, EVAR is associated with a high rate of secondary interventions, which is necessary in up to 8.7% of patients at 12 months with a cumulative incidence of 14% at 4 years.[5] Endoleak is the most frequent complication after EVAR, seen in up to 25% of patients during follow-up.[1] Late rupture is an additional risk with an incidence of 1.5%.[6] As such, the Society for Vascular Surgery practice guidelines recommend imaging surveillance after EVAR to detect these rupture-predisposing late complications.[1] Research regarding the optimal modality and schedule of surveillance is ongoing, although computed tomography angiography (CTA) is typically used, which subjects the patient to chronic exposure to radiation and iodinated contrast agents.

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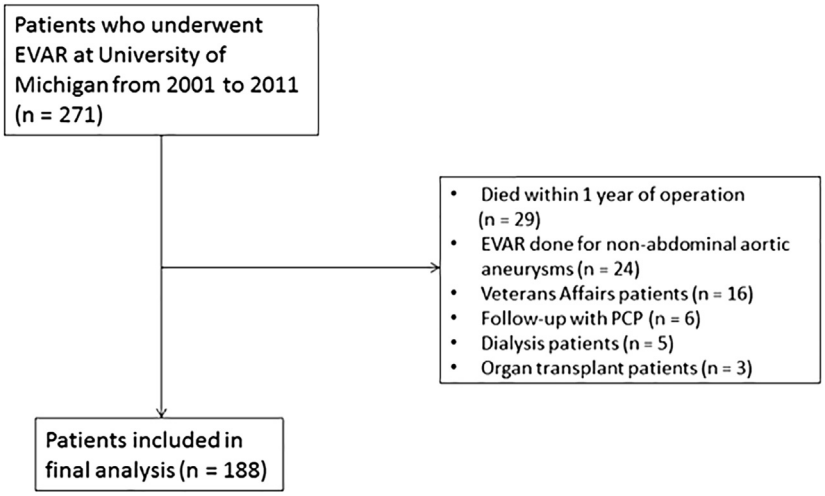

Fig 1. Flow diagram showing selection of patients. *EVAR*, Endovascular aneurysm repair; *PCP*, primary care provider.

Compliance with post-EVAR imaging surveillance remains suboptimal. Compliance rates range in the literature, and risk factors for such remain unclear. Jones et al[7] reported that nearly one third of patients had incomplete follow-up and that these patients had shorter follow-up intervals (34.7 vs 18.8 months; $P < .001$) and an increase in major adverse events (6.1% vs 0.5% in compliant patients), concluding that patients deemed at high risk for noncompliance be advised against EVAR. Leurs et al[8] identified smoking, hyperlipidemia, unfitness for open surgery or anesthesia, and presence of late complication as significantly associated with compliance patterns; in addition, after 84 months of follow-up, compliant patients had higher mortality rates, leading them to conclude that patients with more medical comorbidities received more intensive follow-up. Kret et al,[9] during a median follow-up period of 28 ± 10.5 months, found that only 44% of patients were compliant with follow-up, and in this cohort the presence of late complications was the only significant association. These authors also found that compliance was associated with decreased overall survival, a result further confirmed by Waduud et al.[9,10] Building on these referenced studies, we attempted to identify clinically useful predictors of post-EVAR surveillance compliance as well as to comprehensively examine the effect of compliance on patient survival.

METHODS

Study cohort. The University of Michigan Institutional Review Board approved this study (No. 00076472), and data were obtained retrospectively through review of electronic medical records. Patient consent was not required by our institution's Institutional Review Board, and all patient data were stored without identifiers. All consecutive patients who underwent EVAR between 2001 and 2011 at the University of Michigan performed by the Section of Vascular Surgery were included from a prospectively maintained database. Fig 1 illustrates exclusion criteria, which included patients who died within 1 year of endograft placement, those who had EVAR performed for non-AAAs, those who were Veterans Affairs patients referred to the University of Michigan for EVAR because of case complexity or equipment malfunction, those who were dialysis dependent or transplant patients (who have care coordinators that may confound compliance rates), and those for whom local or primary care follow-up was arranged (whereas these patients may have obtained some form of surveillance imaging with their primary care providers [PCPs], there is no evidence that the images were reviewed by a vascular surgeon or that the PCPs were aware of surveillance guidelines).

Outcomes and covariates. Institutional practice pattern secures 1-month follow-up after EVAR before hospital discharge. Surveillance imaging is performed at this visit, usually in the form of CTA. Although it is subject to individual surgeon variability, surveillance imaging is then performed at 12 months after EVAR and then yearly thereafter, with more frequent imaging performed for complicated cases or those with identified endoleaks. Other forms of surveillance, such as ultrasound or radiography, were also acceptable. When patients miss surveillance appointments, clinic nurses contact them by mail and by phone multiple times. In addition, there would be intermittent correspondence with patients' PCPs, depending on the attending physician.

Compliance with vascular surgeons' recommendations was the main outcome of interest. All but one of our vascular surgeons followed the described surveillance protocol. The one surgeon who deviated would, in certain cases, obtain imaging surveillance between longer intervals. Patients were considered 100% compliant with follow-up surveillance if they followed all of their vascular surgeon's recommendations regarding surveillance imaging. Patients were considered moderately compliant if they missed appointments or surveillance imaging (either one appointment or multiple ones) but continued to follow up thereafter. Patients were considered lost to follow-up if