From the Society for Vascular Surgery

Endovascular aneurysm repair patients who are lost to follow-up have worse outcomes

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ABSTRACT

Background: Society for Vascular Surgery practice guidelines recommend 1- and 12-month follow-up with computed tomography imaging for the year after endovascular aneurysm repair (EVAR). We describe the incidence, risk factors, and outcomes of EVAR patients who are lost to follow-up (LTF).

Methods: All patients undergoing elective EVAR in the Vascular Quality Initiative (VQI) data set (January 2003-December 2015) were stratified according to long-term follow-up method (in-person vs phone call vs LTF). Mortality was captured for all patients by linkage with the Social Security Death Index. Univariable statistics, Kaplan-Meier estimated survival curves, and Cox proportional hazard modeling were used to compare groups. Coarsened exact matching analysis was then performed to refine the association between LTF and risk of post-EVAR death.

Results: During the study period, 11,309 patients underwent elective EVAR (78% in-person follow-up, 11% phone call follow-up, 11% LTF). On univariable analysis, LTF patients had larger baseline aneurysms, higher American Society of Anesthesiologists scores, more comorbidities, and worse baseline functional status compared to patients with in-person or phone call follow-up ($P \leq .05$). Procedural factors (contrast material volume, blood transfusions, postoperative vasopressor use) were higher in the LTF group, as was the incidence of postoperative complications ($P \leq .05$). Accordingly, LTF patients had longer postoperative lengths of stay and were less frequently discharged to home ($P < .001$). Five-year survival was lower for LTF vs phone call follow-up vs in-person follow-up (62% vs 68% vs 84%; $P < .001$). On multivariable analysis correcting for baseline differences between groups, there was a significantly higher risk of death for both the LTF group (hazard ratio, 6.45; 95% confidence interval, 4.89-8.51) and phone call follow-up group (hazard ratio, 3.48; 95% confidence interval, 2.66-4.57) compared with patients who followed up in person ($P < .001$). After coarsened exact matching on 30 preoperative and perioperative variables, 5-year survival after EVAR for LTF vs phone call follow-up vs in-person follow-up was 84.9% vs 84.8% vs 91.9%, respectively (log-rank, $P < .001$). Notably, patients with phone call follow-up had a lower prevalence of documented postoperative imaging compared with patients with in-person follow-up (56.1% vs 85.1%; $P < .001$).

Conclusions: EVAR patients with more comorbidities and a higher incidence of in-hospital complications tend to be more frequently LTF and ultimately have worse survival outcomes. In-person follow-up is associated with better post-EVAR survival and a higher rate of postoperative imaging. Phone follow-up confers a mortality risk equivalent to lack of follow-up, possibly as a result of inadequate postoperative imaging. Surgeons should stress the importance of office-based postoperative follow-up to all EVAR patients, particularly those with poor baseline health and functional status and more complicated perioperative courses. (J Vasc Surg 2016;■:1-11.)

Society for Vascular Surgery (SVS) practice guidelines recommend 1- and 12-month follow-up with computed tomography imaging for the year after endovascular aneurysm repair (EVAR) to identify endoleaks and aneurysmal enlargement.[1] These recommendations are based primarily on expert opinion as high-quality evidence on this topic does not currently exist.[2] There are a few retrospective studies evaluating the utility of these surveillance guidelines. Using an institutional database of 188 patients, Wu et al recently reported that follow-up surveillance is incomplete for more than half of patients who undergo EVAR.[3] Interestingly, compliant patients

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had worse survival compared with patients lost to follow-up (LTF). Similarly, Garg et al demonstrated that more than half of Medicare beneficiaries undergoing EVAR fail to meet current surveillance guidelines[4] and that patients with incomplete surveillance have lower complications and lower aneurysm-related and overall mortality rates.[5]

These findings have led to some discussion about the currently recommended post-EVAR surveillance regimen.[2] Although some patients may require close follow-up because of anatomic complexity and real concerns for endoleak, some physicians argue that straightforward cases may not require such regimented follow-up. One alternative to the classic approach of regular in-person follow-up visits with imaging may be phone call follow-up. However, there are minimal data describing outcomes among EVAR patients with in-person vs phone call vs no follow-up.

In the current study, we aimed to address this knowledge gap. We describe the incidence, risk factors, and outcomes of EVAR patients who are LTF compared with those with in-person and phone call follow-up. We hypothesize that elective EVAR patients with in-person follow-up will have better survival than those patients with either phone call or no follow-up. By better understanding how different follow-up strategies affect post-EVAR mortality, we may be better informed about the appropriateness for different follow-up surveillance regimens in this group of patients.

ARTICLE HIGHLIGHTS

- **Significance:** This study compares 5-year outcomes after endovascular aneurysm repair (EVAR) of patients who were lost to follow-up or had phone call follow-up with those of patients who had follow-up in-person.
- **Type of Research:** Retrospective analysis of prospectively collected Vascular Quality Initiative (VQI) data
- **Take Home Message:** This study of 11,309 elective EVAR patients revealed that patients who are lost to follow-up and those with phone call follow-up have higher 5-year all-cause mortality compared with patients who follow up in-person.
- **Recommendation:** The authors suggest that lack of follow-up after EVAR is a risk factor for increased 5-year mortality.
- **Strength of Recommendation:** 2. Weak
- **Level of Evidence:** B. Low to very low

METHODS

Data source. All patients undergoing elective EVAR in the Vascular Quality Initiative (VQI) data set between January 1, 2003, and December 31, 2015, were analyzed according to long-term follow-up method. Patients were excluded from analysis if they underwent EVAR for symptomatic or ruptured abdominal aortic aneurysm or if they were missing a value for mortality status. Patients were also excluded if they were missing a value for their follow-up variable in the VQI data set because the follow-up status of those patients could not be determined.

Follow-up method was classified according to the VQI variable dictionary[6] and included in-person follow-up, phone call follow-up, and LTF (ie, follow-up information could not be collected). Follow-up is an independently recorded variable within the VQI data set that is separate from postoperative imaging and other variables. Patients are recorded as having only a single follow-up classification in the data set; multiple classifications are not provided. If a patient had multiple follow-up visits, the latest recorded follow-up status was used.

The Institutional Review Board approved this study before its initiation. No patient consent was obtained for this study as the data are sourced from a publically available database.

Outcomes. The primary outcome of the study was mortality. Secondary outcomes were analyzed for the in-person and phone call follow-up groups only and included documented postoperative imaging, endoleak, need for secondary interventions, and conversion to open repair. All outcomes were obtained from the VQI database. Mortality was captured for all patients by linkage with the Social Security Death Index.

Statistical methods. Descriptive statistics are expressed as mean ± standard error of the mean or percentage with count (number), as appropriate. Univariable statistics were used to describe baseline differences of in-person vs phone call vs LTF groups, including *t*-tests for continuous variables and analysis of variance for categorical variables.

Multivariable Cox proportional hazard modeling was then performed to compare risk of death after EVAR for each of the three groups. Stepwise model construction in backward fashion was used to determine associations between patient-, surgeon-, and hospital-level characteristics as well as factors contributing to renal dysfunction and mortality. Any variable demonstrating a P value $\geq .1$ was deemed nonsignificant; these were removed from the model sequentially beginning with the highest P value. Cox models were run in multiple combinations to assess surgeon and center as covariates or clustering influences. Model discrimination was assessed with a Harrell C statistic.

Because of numerous baseline differences between groups, we then performed a coarsened exact matching (CEM) analysis to create matched cohorts for the in-person, phone call, and LTF groups. CEM is a form of matching that allows best-neighbor matching to minimize between-group heterogeneity while maximizing