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The Impact of Compliance with Imaging Follow-up on Mortality After Endovascular Abdominal Aortic Aneurysm Repair: A Population Based Cohort Study

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WHAT THIS PAPER ADDS
No study has explicitly demonstrated a long-term survival benefit from imaging surveillance after EVAR. Such data are critical to justify the cost, inconvenience, and potential morbidity to patients of imaging follow-up. Evidence is provided that supports the hypothesis of a long-term survival benefit associated with regular imaging surveillance after EVAR.

Objective: Compliance with regular imaging follow-up after endovascular aortic aneurysm repair (EVAR) is inconsistent, and evidence of benefit from scheduled long-term surveillance is limited. This study sought to characterize the association between post-EVAR imaging frequency and long-term survival.
Methods: Using administrative health databases for the province of Ontario, Canada, a cohort of patients was identified who underwent EVAR between 2004 and 2014. Minimum appropriate imaging follow-up (MAIFU) was defined as a CT scan or ultrasound of the abdomen within 90 days of EVAR as well as every 15 months thereafter. Multivariate time to event analyses characterized the association between compliance with MAIFU over time and all-cause mortality.
Results: 4988 patients treated by EVAR were identified. Median follow-up was 3.4 years (IQR 2.0—5.3 years) and 90 day mortality was 1.6%. Among those who survived over 90 days, 87% ($N = 4251$ of 4902) underwent at least one CT scan or ultrasound of the abdomen within 90 days, but only 58% ($N = 2859$ of 4902) went on to meet MAIFU criteria. Infrequent imaging correlated with lower follow-up by a vascular surgeon, but not with infrequent primary care or specialist consultations. Consistently meeting MAIFU criteria was associated with a lower risk of death when compared with missing the first imaging follow-up within 90 days (HR 0.82, 95% CI 0.69—0.96, $p = .014$), or when compared with having first imaging follow-up within 90 days but subsequently not meeting MAIFU criteria (HR 0.78, 95% CI 0.68—0.91, $p = .001$). A larger proportion of the follow-up period meeting MAIFU criteria was associated with a lower risk of death.
Conclusions: These data support efforts to improve compliance with imaging surveillance after EVAR.

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INTRODUCTION

The Society for Vascular Surgery and European Society for Vascular Surgery guidelines as well as endovascular graft manufacturers' instructions for use suggest lifelong regular imaging surveillance of patients following endovascular abdominal aortic aneurysm repair (EVAR).[1,2] Endoleak, graft migration, limb stenosis, and sac growth can occur months to years after EVAR.[3–5] Early detection of these events with surveillance imaging may help to prevent associated morbidity and mortality from aneurysm rupture or limb occlusion.

Despite the potential value of radiological follow-up after EVAR, multiple studies document imperfect compliance with post-operative imaging surveillance. In fact, recently published reports consistently that show fewer than 50% of patients adhere to post-operative imaging surveillance guidelines.[6–9] Furthermore, data explicitly demonstrating a long-term clinical benefit from regular post-operative imaging are sparse and no study to date has shown a mortality benefit from imaging surveillance.

Attempts to address this evidence gap are warranted to justify the cost, inconvenience to patients, and potential

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morbidity (e.g. radiation, renal toxicity) of lifelong imaging follow-up. However, understanding whether a morbidity and mortality benefit exists from regular post-operative imaging is a challenging research question. A randomised controlled trial assigning patients to minimal or no follow-up imaging after EVAR would be unethical. Observational studies to address this question require data with specific characteristics: complete follow-up of outpatient imaging and mortality, a long time horizon, and a large sample size. Finally, patient compliance with regular imaging surveillance can be inconsistent and can change over time. Therefore, the time varying nature of follow-up must be taken into account, a fact that has so far been overlooked.[9,10] Given these considerations and the scarcity of existing evidence, this study sought to characterize the frequency of post-EVAR imaging and explore its association with mortality using unique population based datasets.

METHODS

Study design and setting

This was a population based retrospective cohort study of patients with an infrarenal abdominal aortic aneurysm, treated by EVAR, between April 1, 2004 and March 31, 2014 in Ontario, Canada. Using deterministic linkage of regional administrative health and vital statistics data, the frequency of post-operative abdominal imaging and death were captured. Multivariate time to event analysis models were used to explore the association between frequency of post-operative imaging and all-cause mortality.

Ontario is Canada's most populous province with over 13 million residents. All hospital and physician services related to EVAR and post-operative follow-up are fully funded under the provincial single-payer healthcare system.

Data sources

The patient cohort and their covariates and outcomes were identified from population based datasets that were linked using unique encoded identifiers and analysed at the Institute for Clinical Evaluative Sciences. Patients were first identified from the Discharge Abstract Database, which includes demographic, diagnostic, and procedural data as well as discharge disposition for all hospital admissions. All hospitals in Ontario must report these data to the Ministry of Health and Long-Term Care. These records were supplemented with the date of death, including outpatient mortality, as well as Ontario resident status captured from the Registered Person's Database. Abdominal CT and ultrasound after EVAR, performed at any hospital in Ontario or in an outpatient setting, were identified from the Ontario Health Insurance Plan physician claims database. These datasets have been validated for identification of a variety of individual diagnoses and surgical procedures.[11−18] In a multicentre abstraction study comparing records in the Discharge Abstract Database with re-abstracted records, there was almost perfect agreement (kappa = 0.93) on a most responsible diagnosis of aortic aneurysm.[17] Furthermore, combining diagnosis and procedures codes, as detailed below, allows for identification of patients with abdominal aortic aneurysms treated by EVAR with a high level of specificity and accuracy.[19]

Cohort

The cohort included patients admitted to hospital with a most responsible diagnosis of non-ruptured abdominal aortic aneurysm (ICD-10CA diagnosis code I71.4) and a procedure code for endovascular abdominal aortic aneurysm repair (ICD-10-CA procedure code 1.KA.80.GQ-NR-N). Exclusions were patients who underwent an open or endovascular aortic intervention (ICD-10-CA procedure codes 1.KA.50.GQ, 1.KE.50.GQ, 1.KA.76, 1.KA.80.GQ, 1.KA.80.LA) in the previous 2 years, patients who underwent open abdominal aortic surgery (ICD-10-CA procedure codes 1.KA.80.LA, 1.KA.76) on their index admission, and patients who died prior to discharge.

Post-EVAR imaging follow-up

Post-operative CT or ultrasound of the abdomen and the dates of these imaging tests were captured from physician billing claims (CT scan of the abdomen with and without intravenous contrast fee codes X409, X410, X126; ultrasound of the abdomen fee codes J135, J435, J128, J428).

Covariates

The following factors were considered to be potential confounders of the association between the frequency of post-EVAR imaging and mortality: age, sex, income level, rurality of residence, components of the Canadian marginalisation index, medical comorbidities, whether the patient lived in a long-term care facility prior to admission, whether the admission was elective or unplanned, whether the procedure was performed in a teaching hospital, and the given hospital's EVAR volume in the year prior to the patient's surgery. Income level was based on the average household income in the Statistics Canada dissemination area in which the person lived.[20] Place of residence was also characterized by a measure of rurality.[21] Potential inequality of access to healthcare resources was accounted for through the use of individual components of the Canadian marginalisation index (dependency, material deprivation, ethnicity, residential instability), a novel geographic area based measure of socioeconomic status.[22] The Canadian Marginalisation Index was shown to be associated with health outcomes and behaviors that impact on health (e.g. obesity, smoking, annual flu shot).[22]

Individual comorbidities prior to admission were captured according to validated algorithms using emergency department visits, hospital discharge records, and physician billing claims within the previous 2 years. These comorbidities included prior myocardial infarction, congestive heart failure, chronic kidney disease, hypertension, diabetes, and chronic obstructive pulmonary disease.[11−17] Cormobidity level was further characterized using the Johns Hopkins Adjusted Casemix System (ACG version 10).[23]

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