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Functional status of nursing home residents before and after abdominal aortic aneurysm repair

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Abstract

Objectives—Although many trials have evaluated abdominal aortic aneurysm (AAA) repair, the impact of these procedures on the functional status of frail elderly patients is not well described. The effects of elective open AAA repair (OAR) and endovascular AAA repair (EVAR) and comorbidities were evaluated for their impact on functional trajectories after discharge.

Methods—Medicare inpatient claims were linked with nursing home assessment data to identify elective admissions for OAR and EVAR. A functional score (0–28; higher scores indicating greater impairment) was calculated before and after interventions. Logistic regression was used to develop a propensity score for receiving EVAR because residents were not randomized. Hierarchical linear modeling determined the effect of surgery on residents' function, controlling for pre-hospital function, hospital length of stay (LOS), stroke, and the propensity score.

Results—Fifty-two residents underwent OAR and 161 residents underwent EVAR. Most (65.3%) were men and 62.0% were from 76 to 85 years old. Mean LOS was 8.3 days for OAR and 5.1 days for EVAR. Almost half (47.4%) of the residents had good pre-hospital function (activities of daily living [ADL] score 0–10), and 48.4% were moderately impaired (ADL score 11–20). Higher baseline ADL score, increased LOS, and stroke were associated with worse trajectories. Procedure type was not significantly related to post-surgery function or the subsequent rate of improvement.

Conclusions—OAR and EVAR were associated with similar initial declines and comparable post-operative trajectories, suggesting that less invasive EVAR was not associated with improved functional preservation compared with OAR. LOS was found to be higher than expected in the frail elderly after EVAR; longer stays were associated with poorer functional trajectories. Higher baseline ADL scores were significantly associated with inferior functional status after both procedures. Evaluation of preoperative function may assist physicians in predicting outcomes in this high risk population.

BACKGROUND

In the United States, the number of cases for abdominal aortic aneurysm (AAA) repair has remained stable over the last ten years.¹ However, the type of repair (endovascular or open) has dramatically changed, with recent trends moving towards an endovascular approach rather than an open approach, especially for the elderly.^{2,3} While there is no long-term difference in survival between the endovascular aneurysm repair (EVAR) and open aneurysm repair (OAR)⁴, there are few studies regarding functional outcomes and the impact on patients after elective surgical intervention. One functional outcome that can be measured to determine the impact of AAA repair is activities of daily living (ADL). An individual's quality of life is intimately linked with independence in ADLs⁵ and conversely, ADL impairments are associated with hospital admission,⁶ death,⁷ and persistent disability.⁸ Therefore, the purpose of this study was two-fold: 1) to describe ADL scores of nursing home residents before and after hospitalization for elective AAA and 2) to determine the effect of procedure type on the ADL scores of residents undergoing open versus endovascular repair. The specific aim of this study was to determine if procedure type was associated with either improved or worsening post-hospital trajectories of ADL function.

METHODS

Design and sample

A retrospective cohort study was performed, combining Medicare inpatient claims data with nursing home assessment data.

Population

We included patients who were admitted for either endovascular or open elective AAA repair. International Classification of Disease, Ninth revision, codes for selecting diagnoses and procedures are as follows: 441.4 – AAA; 39.71 – EVAR; 38.34, 38.44 or 38.64 – OAR. Qualifying stays were preceded by at least one MDS assessment within 60 days of hospital admission, had hospital length of stay less than 31 days, admission date on or after June 1, 2006, and a discharge date before August 1, 2007. Exclusions included residents less than 67 years old as of January 1, 2006; residents with any HMO membership in 2006–2007 (HMOs do not report hospital data); residents without a record in the beneficiary summary files for 2006–2007; residents with no Medicare Part A coverage for either year; residents with more than 20 hospital stays in 2006–2007; and residents who died in the hospital.

Data and measures

Medicare inpatient claims for 2006–2007 were linked with nursing home Minimum Data Set (MDS) assessments to form a cohort of long-stay residents who were hospitalized for elective AAA repair. MDS assessments are federally mandated for all nursing homes that are certified by Medicare or Medicaid and are used to develop comprehensive care plans.⁹ Each resident's last pre-hospital MDS assessment and all post-hospital MDS assessments were included during 6 months after hospital discharge, up to the point of re-admission or death.

The MDS ADL long-form score¹⁰ was used to represent ADL function. The functional score is the summation of seven variables: bed mobility, self-transfer, locomotion on unit, dressing, eating, toileting, and personal hygiene. Each component is scored from 0 to 4, where 0 indicates that the resident is independent in performing the activity and 4 indicates total dependence on others. As recommended by the authors, scores of 8, indicating that the activity did not occur during the prior week, were reassigned to 4. The total functional score ranges from 0 to 28, where 0 represents complete independence in all seven activities, and 28 represents complete dependence. As little as a 1-point change in a patient's functional score can be clinically significant, as this indicates new supervision or a move towards more dependence in any one activity area.^{11,12}

Demographics were determined from beneficiary summary files and MDS assessments. Comorbid diagnoses present prior to the hospital admission were derived from Medicare data, prior MDS assessments, and the Chronic Condition Warehouse data furnished by the Centers for Medicare and Medicaid. The Cognitive Performance Scale (CPS) was used to represent residents' cognition.¹³ The CPS ranges from 0 to 6, where 0 represents no cognitive impairment and 6 represents severe cognitive impairment.

Data collection

All data were obtained from the Centers for Medicare and Medicaid Services (Data Use Agreement 19189).

Statistical analysis

SAS for Windows, version 9.3 (SAS Institute, Cary, NC), was used for all analyses. Characteristics of residents who received endovascular or open procedures were compared using chi-square analysis. Because patients were not randomized to procedure type, we used logistic regression to develop a propensity score¹⁴ to balance the characteristics of the open and endovascular groups. Model discrimination was evaluated with the c-statistic, which varies from 0.5 (no better than a coin flip) to 1 (perfect fit). Model calibration was assessed with the Hosmer-Lemeshow goodness-of-fit statistic, with non-significant tests indicating adequate fit across the range of data. The estimated probability of receiving an endovascular procedure was divided into quartiles and used as a categorical independent variable in the ADL model. Covariate balance with and without propensity adjustment was evaluated by examining the absolute standardized differences and variance ratio for each covariate.¹⁵ A standardized difference of greater than 10% between open and endovascular groups was regarded as evidence of imbalance.

In addition to the propensity score, residents' demographic characteristics, type of procedure, pre-hospital diagnoses, CPS,¹³ Charlson Comorbidity Index,¹⁶ and baseline ADL score were included as independent variables in a linear mixed model of post-hospital ADL performance. The Charlson Index reflected both previous and current diagnoses. As the number and timing of ADL measurements varies over individuals, the ADL intercept and slope were treated as both fixed and random effects.¹⁷ Time since hospital discharge was measured in months. The initial model included all two- and three-way interactions involving time, diagnosis, and procedure type as well as selected covariates (demographic

characteristics, prior health care utilization). We retained covariates and interaction terms that remained statistically significant after propensity adjustment as well as age, diabetes, and the interaction between baseline ADL score and time.

Due to concern that truncating a resident's ADL trajectory from either death or readmission constituted informative dropout, a shared parameter model was also tested,¹⁸ where ADL trajectory and time to dropout were modeled simultaneously. Because the parameter estimates from the two modeling strategies were very similar, and because the focus of this paper is the comparison of expected ADL trajectories, only parameter estimates from the simpler mixed model are presented.

To compare post-hospital trajectories of various groups of residents, we plotted ADL trajectories based on chosen covariates – EVAR versus OAR, baseline ADL score, hospital LOS.

Ethical considerations

This study was a retrospective statistical review of de-identified Medicare data, therefore no patients were subject to harm during this investigation. The Health Sciences Institutional Review Board at the University of Missouri approved this study.

RESULTS

Demographics, comorbid conditions, and hospital length of stay of the derived cohort are presented in Table 1. We identified a total of 213 nursing home residents with qualifying admissions who underwent either OAR (52, 24.4%) or EVAR (161, 75.6%). The majority of patients were in the 76–85 age group (62%), 197 patients were white (92.5%), and almost two-thirds were male (65.3%). Compared with open procedures, endovascular repair was more common among those age 76 years or older (123, 76.9%). The CPS score was similar in both OAR and EVAR populations. The presence of comorbid conditions was similar between groups except for prior transient ischemic attack (TIA) or stroke (17.3% in OAR compared to 37.9% in EVAR, $P<0.05$).

Mean length LOS was 8.3 days for OAR and 5.1 days for EVAR. The majority of patients undergoing endovascular repair were discharged within 5 days of admission (70.2%) whereas only 9.6% of patients who had OAR stayed less than 5 days ($P<0.05$). Most patients with an OAR had a hospital length of stay that spanned 6 to 10 days (73.1%) compared with only 37 (23%) EVAR patients. Although not statistically significant, those patients who did have a prolonged hospital stay greater than 11 days tended to have an OAR (17.3%), compared with only 6.8% of patients having EVAR. In the multivariate propensity model, prior stroke, male gender, older age, and congestive heart failure were more common among those who had an EVAR.

Parameter estimates for the model of ADL following AAA repair are shown in Table 2. Several variables were associated with increased ADL scores following hospitalization (worse function), including higher baseline ADL score, greater LOS, and history of prior stroke. Prior stroke or TIA was associated with a 2.4-point worsening in post-procedure

ADL scores. Time was associated with a 0.6-point improvement in ADL score per week. Procedure type was not significantly related to post-surgery impairment scores or the subsequent rate of change.

Figure 1 shows the average ADL trajectory for residents during the 16 weeks following OAR and EVAR for a given set of covariates. The gray trajectory compares functional outcome scores following OAR (dotted) or EVAR (solid) for groups of residents who were male, had a 12-day hospital stay, an initial ADL of 18, and a prior stroke/TIA. As is seen in the figure, the trajectory is similar for both OAR and EVAR cases for the treatment of open aortic repair. The black trajectories compare functional outcome scores following OAR (dotted) or EVAR (solid) for groups of residents who were male, had a 5-day hospital stay, and an initial ADL of 9. As is seen in the figure, the trajectory is similar for both OAR and EVAR cases for the treatment of aortic repair. Procedure type was not significantly related to post-surgery impairment scores or the subsequent rate of improvement.

DISCUSSION

This analysis demonstrates that procedure type was not significantly related to post-surgery impairment scores or the subsequent rate of improvement in our nursing home sample. As endovascular abdominal aortic aneurysm repair increases in frequency in the aged population, these data suggest that an endovascular approach to AAA may be more physically demanding on patients than previously believed in the nursing home population. ADL scores improved following both EVAR and OAR, however, our trajectories indicate that the less invasive endovascular approach was not associated with improved functional preservation when compared with OAR in the nursing home population.

In our study, there were several factors in the patient population that appeared to have a significant impact on patient's functional status following aneurysm repair. The three most significant in our study were prior stroke or TIA, their baseline ADL scores, and hospital LOS. Out of those previously mentioned, the most important single factor is having had a prior stroke or TIA. If the patient had a prior stroke/TIA, then their post-operative scores appeared to be considerably higher, indicating decreased level of functioning independently. Similarly, baseline ADL scores were very important in impacting the functional scores. Worse "baseline" pre-hospital MDS ADL scores were associated with significantly worse post-procedure scores after either EVAR or OAR. Finally, hospital LOS was higher than expected in the elderly population following EVAR. The LOS was associated with worse post-procedure ADL scores as well.

Several authors have looked at functional outcomes after AAA repair. Williamson et al.¹⁹ evaluated 154 elective, non-emergent open AAA repair in an elderly population with a mean age of 69 years. They described a significant decline in patients following OAR repair, with only 64% of patients reporting a full recovery after a mean of 3.9 months. Additionally, only 67% of patients who were ambulatory pre-hospital remained ambulatory following OAR. Tambyraja et al.²⁰ provided a prospective case-control series of 57 patients undergoing OAR for ruptured AAA. Their group reported return to baseline quality of life within 6

months after both elective and emergent OAR for ruptured AAA using the Short Form-36 (SF-36) health survey.

Furthermore, authors have compared quality of life outcomes after EVAR and OAR. Aljabir et al.²¹ analyzed quality of life outcomes following both EVAR and OAR using the SF-36 health survey. They reported significantly lower SF-36 scores in the EVAR group after 6 months when compared with the OAR group. Both groups had lower scores in the immediate post-operative period (1 week, and 1 month), however, after 6 months those scores did improve. The EVAR patients did have a more rapid return to per-operative scores in two SF-36 categories (role emotional and physical function) when compared to the OAR group. These findings do somewhat parallel our own study. Although the endovascular approach to AAA may be less invasive, there appears to be a significant association with both functional outcomes and quality of life within the nursing home population.

Other authors have assessed functional health status as an outcome measure based on patient comorbidities and type of aneurysm repair. Functional health status was measured prospectively using the SF-36 Health Survey. Physical and mental health were higher during the 3 months following EVAR compared with open repair: physical function, vitality, and emotional role. This analysis concluded that patients undergoing abdominal aortic aneurysm (AAA) repair by open technique (compared to EVAR) had significantly impaired functional health in the first 3 months after surgery.²² In our analysis of the frail elderly, we did not see a significant difference regarding functional outcomes associated with repair type. These results may suggest that in the nursing home population, the type of repair is not as significant a predictor of functional outcome as the baseline score.

Prinssen et al.²³ also compared quality of life outcomes in a randomized trial comparing EVAR and OAR. They described both groups having an initial decline in quality of life scores using SF-36 and EuroQoL-5D. There was a small yet statistically significant advantage in the first three weeks towards EVAR. However, in the long term, their study suggested that OAR may have a better quality of life in the 6 month and beyond period.

There are limitations to this study. We used a large, national database to select a highly specific cohort of long-stay nursing home residents; therefore, these results may not translate into generalizable results for other elderly patient populations. Given that patients who died during the hospital stay and who had more than 20 hospital admissions were excluded, this cohort may over-represent healthier patient populations in the post-hospital trajectories. Linking nursing home assessments to Medicare data provided more information on diagnoses than is available on the MDS alone. However, the timing of MDS assessments and hospital stays required exclusion of many residents to provide adequate data before and after hospitalization for meaningful analysis. Finally, although we selected patients for EVAR or OAR in the elective setting, it is possible that coding schemes from different hospitals may vary.

CONCLUSION

The rate of AAA repair in the US has remained constant over the last decade,²⁴ however, the trend has been moving toward increasing endovascular AAA repair in the frail, elderly population. As there becomes more of a focus on outcomes following surgical interventions, analyzing functional scores will not only help surgeons with perioperative decision-making, but will also improve patients' overall physical health and recovery in the postoperative period. When selecting elderly patients for either elective EVAR or elective OAR, functional outcomes will be a useful framework to aid the physician in determining the most appropriate procedure for that individual. After matching patients for initial ADL scores, comorbidities, and LOS, it appears that EVAR may have similar ADL function when compared to OAR. This analysis has demonstrated that EVAR was not associated with a significant functional improvement for the frail elderly undergoing repair. It is important for vascular surgeons to take into account pre-hospital functional status and comorbid conditions with the realization that in the frail nursing home population the use of less invasive endovascular procedures may not confer a functional benefit.

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Figure 1.

Average trajectories of ADL function following AAA repair for groups of nursing home residents with selected characteristics. The ADL scale varies from 0 to 28, with higher scores indicating worse function. Trajectories are predicted from the regression model in Table 2.

Table 1

Characteristics of Nursing Home Residents Undergoing Elective AAA Repair.

	OAR (N=52)	EVAR (N=161)	Total (N=213)
Demographic characteristics			
Age 67–75	15 (28.8)	38 (23.6)	53 (24.9)
76–85	32 (61.5)	100 (62.1)	132 (62.0)
86+	5 (9.6)	23 (14.3)	28 (13.2)
Race White	49 (94.2)	148 (91.3)	197 (92.5)
Other	3 (5.8)	13 (8.7)	16 (7.5)
Sex Male	30 (57.7)	109 (67.7)	139 (65.3)
Female	22 (42.3)	52 (32.3)	74 (34.7)
Cognitive Performance Scale 0–2	45 (86.5)	133 (82.6)	178 (83.6)
3–6	7 (13.5)	28 (17.4)	35 (16.4)
Comorbid Conditions			
Coronary heart disease	27 (51.9)	91 (56.5)	118 (55.4)
Chronic kidney disease	18 (34.6)	58 (36)	76 (35.7)
Congestive heart failure	16 (30.8)	58 (36)	74 (34.7)
Diabetes	17 (32.7)	61 (37.9)	70 (32.9)
Stroke/transient ischemic attack*	9 (17.3)	61 (37.9)	70 (32.9)
Hospital length of stay 0–5 days*			
6–10 days	38 (73.1)	37 (23)	75 (35.2)
11+ days	9 (17.3)	11 (6.8)	20 (9.4)

* Denotes P<0.05

Numbers in each column represent frequency and (percentage).

Table 2

Parameter estimates for linear mixed model of ADL trajectory following AAA repair

Variable	Parameter estimate (95% CI)	P-value
Intercept	6.331 (3.85, 8.82)	<0.0001
EVAR (vs. OAR)	−0.185 (−1.69, 1.32)	0.810
Week	−0.607 (−0.96, −0.25)	0.002
Week × EVAR	0.205 (−0.19, 0.60)	0.310
Baseline ADL score (0–28)	0.538 (0.44, 0.63)	<0.0001
Hospital length of stay (days)	0.252 (0.12, 0.38)	<0.0001
Prior stroke/TIA (1=yes, 0=no)	2.361 (1.01, 3.71)	0.001
Day of first post-hospital MDS	−0.183 (−0.33, −0.03)	0.017
Quintile of propensity score		0.718

ADL = activities of daily living

AAA = abdominal aortic aneurysm

EVAR = endovascular AAA repair

OAR = open AAA repair

TIA = transient ischemic attack

MDS = Minimum Data Set