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The Consequences of Real Life Practice of Early Abdominal Aortic Aneurysm Repair: A Cost-Benefit Analysis

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WHAT THIS PAPER ADDS

The 55 mm intervention threshold for abdominal aortic aneurysm (AAA) repair is uniformly accepted; however, vascular registry data show a high incidence of premature repair (i.e., earlier than indicated by the consensus guidelines) in clinical practice. To estimate the consequences of the practice of premature repair, a simulation on the basis of the Medicare data for endovascular aneurysm repair was performed. Conclusions of this simulation are that although premature AAA repair beneficially influences survival, it comes with considerable costs (approx. 1 million USD per prevented aneurysm related death) thereby negatively impacting EVAR cost effectiveness.

Background: The reported 54 mm median intervention diameter for endovascular aneurysm repair (EVAR) in the Vascular Quality Initiative and European data from the Pharmaceutical Aneurysm Stabilisation Trial (PHAST) implies that in real life the majority of abdominal aortic aneurysm (AAA) repairs occur at diameters smaller than the consensus intervention threshold of 55 mm. This study explores the potential consequences of this practice.
Methods: The differences between real life AAA repair and consensus based intervention threshold were explored in reported data from vascular quality initiatives and PHAST. The subsequent consequences of advancement of endovascular aneurysm repair (EVAR) were estimated using a multistate model based on life tables for the EVAR Medicare population.
Results: There appears an approximate 5 mm difference in AAA diameter between real life practice and consensus intervention threshold. Assuming a 2.5 mm annual growth rate, this results in an approximately 2 year advancement of AAA repair. According to the model used, early repair reduces overall small aneurysm patient mortality by 2.3%, it results in 21.9% more EVAR procedures, more EVAR related deaths, and 42.3% and 36.8% more open and endovascular re-interventions, respectively. Cost—benefit estimates imply 482 fewer AAA related deaths, but 140 extra EVAR related deaths for a population of more than 30,000 AAA patients, and a 300 million USD increase in health costs for the 8 year observation period in the Medicare population.
Conclusions: In the real life situation a large proportion of EVAR procedures appear to occur before reaching the consensus threshold. Although this reduces mortality, it comes at a cost of approximately 1 million USD per prevented rupture related death.

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INTRODUCTION

The United Kingdom Small Aneurysm Trial and Aneurysm Detection and Management (ADAM) trial reported no survival benefit for early elective open repair of abdominal aortic aneurysms (AAAs) measuring 40—54 mm.[1—3] Similar findings were reported for early elective endovascular aneurysm repair (EVAR) by the Comparison of surveillance versus aortic endografting for small aneurysm repair (CAESAR) and Positive Impact of Endovascular Options for Treating Aneurysms Early (PIVOTAL) trials.[4,5] Consequently, current guidelines for AAA treatment recommend ultrasound follow-up for AAAs smaller than 55 mm for male patients, after which point surgical repair should be considered.[6] This trade- off is reflected by the respective 59 and 65 mm mean intervention diameters in the Vascular Study Group of New England (VSGNE) database and the EVAR 1 trial.[7,8]

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Remarkably, the reported 54 mm median intervention diameter for EVAR in the Vascular Quality Initiative suggests that in a real life setting AAA repair occurs earlier than indicated by prevailing guidelines.[9] Similar observations in the Pharmaceutical Aneurysm Stabilisation Trial (PHAST), a nationwide study performed in the Netherlands, indicate that the majority of AAA repairs in patients under surveillance for a small (i.e., <55 mm) AAA occurred at diameters less than 55 mm.[10]

Although earlier repair may prevent rupture of small AAA in some patients, premature repair comes with potential clinical and financial consequences. To that end, a simulation on basis of a multistate model using real life data from the EVAR procedures performed in the Medicare population was established.[11]

METHODS

Simulation model

A multistate model was applied,[12] which is used to model movement of patients among various states in order to analyse and compare (time to) events. This study is based on modeling data of 39,966 Medicare patients (22.3% female) who received elective EVAR between 2001 and 2009.[11] The 8 year life table for this Medicare EVAR population was used as a basis for the model.

In this report, the consequences of a 5 mm advancement of AAA repair for a "real life" setting are simulated. This 5 mm advancement is based on observations of the PHAST trial[10] and on the data from the Vascular Quality Initiative[9] and the VSGNE.[7] More specifically, data from the PHAST trial show a 52 (2.7) mm mean (SD) intervention diameter for the 43 patients undergoing elective AAA repair. This number is close to the 54 mm median diameter for elective EVAR in the Vascular Quality Initiative.[9] In contrast, data from the VSGNE indicate a 59 mm mean intervention diameter for elective AAA repair.[7]

Consequently, there appears to be a 5 mm difference in mean intervention diameters in the VSGNE and Vascular Quality Initiative[7,9] and a 5 mm discrepancy between the local size readings and the protocolled trial readings in the PHAST trial,[10] suggesting that AAA repair is often performed at a 5 mm lower diameter in real life settings. Assuming 2.5 mm as the average yearly growth rate for 50 mm AAAs,[10] this 5 mm difference will result in an approximately 2 year earlier repair than indicated by the ultrasound based guidelines. On this basis, it was decided to model the consequences of 2 year premature AAA repair for a real life setting.

Primary outcome measures were the number of EVARs, deaths, and re-interventions. Data for the Medicare cohort[11] hold information on open and endovascular re-interventions. Open re-interventions were defined as AAA related secondary open surgical procedures (e.g., open repair of aneurysm, repair of false aneurysm, removal of graft, or graft infection). Endovascular re-interventions were defined as AAA related secondary endovascular procedures (e.g., stent graft extension, embolisation, aortic or iliac angioplasty).[11]

The simulation model was constructed based on the following assumptions:

(1) the proportion of deaths in the population remains equal and is not influenced by postponing repair;
(2) the proportion of AAA rupture after EVAR is not influenced by postponing repair;
(3) the AAA growth rate is 2.5 mm/year and remains stable over 2 years;[10]
(4) throughout 8 years of follow-up, interventions related to the management of the AAA or its complications will shift 2 years, but the proportion will remain equal;
(5) half of the patients who present with a ruptured AAA die before emergency repair and will be added to the number of deaths. The incidence of rupture for AAAs of 40—55 mm per year in the model was 1%;[1]

Table 1. Life table with 8 year events of 39,966 Medicare patients who received EVAR.

Interval start	Interval end	Number undergone repair/at risk[a]	Number of ruptures	%	Number of endovascular re-interventions	%	Number of open re-interventions	%	Number of deaths	%	Lost to follow-up	%
0	0.5	39,966	166	0.42	787	1.97	65	0.16	1911	4.78	0	0
0.5	1.0	38,055	138	0.36	635	1.67	38	0.10	1220	3.21	0	0
1.0	1.5	36,835	106	0.29	477	1.29	38	0.10	1149	3.12	1458	3.96
1.5	2.0	34,228	77	0.22	380	1.11	34	0.10	1263	3.69	1306	3.82
2.0	2.5	31,659	84	0.27	342	1.08	35	0.11	1180	3.73	1595	5.04
2.5	3.0	28,884	62	0.21	275	0.95	37	0.13	1127	3.90	1530	5.30
3.0	3.5	26,227	51	0.19	242	0.92	26	0.10	1074	4.10	1807	6.89
3.5	4.0	23,346	49	0.21	198	0.85	21	0.09	1034	4.43	1732	7.42
4.0	4.5	20,580	46	0.22	143	0.69	16	0.08	939	4.56	2069	10.05
4.5	5.0	17,572	41	0.23	130	0.74	23	0.13	808	4.60	1870	10.64
5.0	5.5	14,894	40	0.27	106	0.71	18	0.12	741	4.98	2057	13.81
5.5	6.0	12,096	28	0.23	65	0.54	13	0.11	631	5.22	1772	14.65
6.0	6.5	9693	32	0.33	48	0.50	7	0.07	540	5.57	1622	16.73
6.5	7.0	7531	11	0.15	39	0.52	6	0.08	391	5.19	1578	20.95
7.0	7.5	5562	19	0.34	37	0.67	7	0.13	333	5.99	1440	25.89
7.5	8.0	3789	12	0.32	20	0.53	8	0.21	207	5.46	—	—
Total			962		3924		392		14,548			

[a] Number at risk = number at risk previous half year — (number of deaths + lost to follow-up).

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