TITLE: Elective Endovascular Abdominal Aortic Aneurism Repair versus Open Surgery: A Review of the Clinical and Cost-Effectiveness

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CONTEXT AND POLICY ISSUES:

Abdominal aortic aneurism (AAA) occurs in 5% of men and 1% of women over the age of 65 years, and the rupture of an AAA is a significant cause of death. Elective repair of AAA (repair of a non-ruptured aneurism) by a conventional open surgical approach has reasonable long-term survival, but it carries a high risk to older patients or those with comorbidities such as cardiovascular or pulmonary conditions. In contrast to open surgery, endovascular AAA repair (EVAR) is a catheter-based procedure that does not require an abdominal incision or dissection and clamping of the aorta. In Canada, the development of the endovascular program at London Health Sciences Centre has experienced a doubling of elective aneurism cases during 1997 to 2003, with elective EVAR constituting 28% of the entire elective AAA repairs. The clinical and cost-effectiveness of elective EVAR compared with open surgery repair is reviewed to aid in decision-making.

RESEARCH QUESTIONS:

1. What is the clinical effectiveness of endovascular aortic aneurism repair compared with traditional surgical repair for the treatment of patients with abdominal aortic aneurism?

2. What is the cost-effectiveness of endovascular aortic aneurism repair compared with traditional surgical repair for the treatment of patients with abdominal aortic aneurism?

METHODS:

This report is an update to an HTIS report completed in April 2008. Information contained within the original report is included in the current report, as well as new information published since April 2008. The original limited literature search conducted in April 2008 included English results.
published between 2003 and March 2008 from key health technology resources. An updated search was conducted in September 2009 on key health technology assessment resources, including PubMed, The Cochrane Library (Issue 3, 2009), University of York Centre for Reviews and Dissemination (CRD) databases, ECRI, EuroScan, international health technology agencies, and a focused Internet search. The search was limited to English language articles published between 2008 and August 2009. Filters were applied in both the 2008 and 2009 searches to limit the retrieval to health technology assessments, systematic reviews, meta-analyses, randomized controlled trials, and economic studies.

SUMMARY OF FINDINGS:

Clinical effectiveness of EVAR

A rigorous meta-analysis with a systematic literature search from 1966 through 2006 included four RCTs that compared elective EVAR versus open repair for large AAAs (≥5.5cm) in 1,532 patients. EVAR reduced 30-day all-cause mortality (relative risk 0.33 [CI 0.17 to 0.64]) but not mid-term (up to 4 years) mortality (relative risk 0.95 [CI 0.76 to 1.19]). There was a significant reduction in length of hospital stay with EVAR compared to open repair (6.2 days versus 11.5 days). These results were replicated in other meta-analyses. A prospective trial in 2008 also agreed with these meta-analyses and found that the 30-day mortality was reduced with EVAR.

A meta-analysis of 35 studies compared elective cases of EVAR versus open surgery. There was a total of 20,715 patients and the size of the AAA was not reported. The literature was searched until 31 July 2007 and it is unclear what type of study designs were included. The time spent in intensive care (weighted mean difference -36.2 hours, p<0.001) and the post-operative stay (weighted mean difference -5.4 days, p<0.001) were significantly shorter with EVAR compared with open surgery. EVAR was also associated with a significant reduction in post-operative cardiac complications (odds ratio 0.57, p=0.002) and respiratory complications (odds ratio 0.25, p<0.001). EVAR patients had an increased risk of graft thrombosis (odds ratio 6.25, p=0.04). Both 30-day mortality (odds ratio 0.46, p<0.001) and long-term (six years) aneurism-related mortality (hazard ratio 0.39, p<0.01) were significantly lower with EVAR. However, long-term all-cause mortality (hazard ratio 0.94, p=0.520) was not statistically different. It is important to note that some of the included studies in the meta-analysis were not RCTs. However, the authors did state that, when only RCTs were considered, EVAR demonstrated significant reductions in operative time, blood loss, and post-operative length of stay. The incidence of post-operative respiratory (but not cardiac) complications and the 30-day mortality rate were significantly lower after EVAR compared with open surgery when only RCTs were considered.

Two systematic reviews evaluated the use of EVAR and elective open repair in the very elderly (≥80 years). The first included observational studies published from 1966 to June 2006. Thirty-four studies on open repair, seven on EVAR, and two on both were included in the analysis, with 1,534 patients in the open repair group, and 1,045 patients in the EVAR group. The peri-operative mortality rate was 7.5% after open repair, and a five-year median survival of 60% was reported. In contrast, EVAR had a peri-operative mortality rate of 4.6%. Follow-ups in the EVAR studies were less than five years, and hence five-year median survival could not be calculated. The second systematic review considered all types of studies (excluding case reports, abstracts, and unpublished data) published from 1975 to May 2008. Thirty-five studies on open repair, five on EVAR, and four on both were included in the analysis, with 1,807 patients in the open repair group, and 1,159 patients in the EVAR group. The size of the AAA was >5.5 cm and the mean age of the participants was less than 86 years. The peri-operative death rate was higher after open repair (5.6%) than after EVAR (4.5%), but this was not
statistically significant (p=0.170). There was a statistically significant 2-fold risk of major systemic complications after open repair (26.9%) compared with EVAR (16.5%, p<0.001).12

Cost-effectiveness of EVAR

A systematic review of economic studies published between 1999 and 2005 reporting the cost and/or cost-effectiveness of elective EVAR and/or open surgery of non-ruptured AAAs included three RCTs, 12 case series, four Markov models, and one systematic review.13 All studies found that EVAR costs more than open surgery. Among patients with AAA ≥5.5cm, EVAR had greater short and long term costs with no improvement in overall survival or quality of life beyond one year.

A randomized trial compared the cost-effectiveness of elective EVAR and open repair in 351 patients in The Netherlands.14 EVAR was associated with additional €4293 direct costs (€18,179 vs. €13,866 [CI €2770 to €5830]). Routine use of elective EVAR in patients also eligible for open repair did not result in a quality adjusted life-year (QALY) gain at one year postoperatively, provided only a marginal overall survival benefit, and was associated with a substantial increase in costs.

A decision model to estimate the lifetime costs in UK and QALYs with elective EVAR and open repairs was constructed.15 EVAR costs £3,800 (CI £2,400 to £5,200) more per patient than open repair and produced fewer lifetime QALYs.

A Swedish cost study based on case records and hospital accounting systems found no difference in total cost between EVAR (€26,382) and open repair (€29,786, p=0.336).16 The EVAR patients in this cohort were older (76 years versus 70 years, p<0.001) and had more co-morbidities compared with the patients undergoing open repair, whereas the open repair patients had more anatomically complex aneurisms.

More recently, two economic analyses were published by the same Canadian investigators.17,18 The first analysis compared the cost-effectiveness and cost-utility of elective EVAR and open repair in patients at high risk of surgical complications with AAA >5.5 cm.18 Over a time horizon of one year, EVAR had a lower total cost of C$24 (C$34,146 for EVAR versus C$34,170 for open repair), with more life-years (0.11 [CI 0.022 to 0.213]), and more QALYs (0.025 [CI -0.075 to 0.128]). EVAR dominated open repair in terms of incremental cost per life-year gained and incremental cost per QALY, but these findings were not statistically significant.18 The second analysis evaluated the cost-effectiveness of elective EVAR versus open surgical repair in male patients who are medically suitable for either procedure with AAA > 5.5 cm. A probabilistic, decision analytic model was used, with a time horizon of 10 years. The expected cost of EVAR and open repair was estimated to be C$31,908 and C$18,522 respectively. The EVAR treatment arm was expected to produce 0.03 more life-years and 0.05 more QALYs compared to open repair, with an incremental cost per QALY of C$268,337. Cost per quality remained similar under different scenarios such as changing the cohort’s age and the model’s time horizon.17

The NHS published a guidance document wherein an economic evaluation compared the cost-effectiveness of EVAR and open surgery in patients with unruptured AAA.7 For patients of moderate fitness (moderate risk of operative mortality), with AAA of 6.5 cm, and 75 years of age, the incremental cost-effectiveness ratio was £12,000 per QALY gained. This was based on: a hazard ratio for late AAA-related death with EVAR relative to open repair of 1.5; an excess non-aneurism mortality of EVAR of 1.072; a hazard ratio for late re-intervention of 1.5; an
annual cost of follow-up for EVAR of £54; and no cost differential for EVAR and open repair for the initial procedure.\textsuperscript{7}

**EVAR for repair of ruptured AAA**

In addition to elective repair, clinical effectiveness of emergency repair of AAA (repair of a ruptured aneurism) by EVAR versus open surgery was also the focus of many clinical trials which were reviewed in a recent systematic review and meta-analysis\textsuperscript{13} that covered publications from 1994 to 2007. Emergency EVAR was associated with a statistically significant reduction in 30-day mortality, intensive care unit stay, hospital stay, blood loss, and operative time compared to open surgery. A Cochrane review\textsuperscript{19} that covered trials until 2006 on the same topic also found similar results.

A systematic review and meta-analysis that compared EVAR with emergency open repair in both patients with ruptured AAA and patients with symptomatic intact aneurisms, included 21 comparative studies (no RCTs included) published between January 1994 and May 2007.\textsuperscript{20} This systematic review found that patients undergoing EVAR had significantly reduced 30-day mortality, significantly shorter ICU stay, significant reduction in hospital stay, significant reduction in blood loss, and a significant reduction in procedure time compared with patients who underwent open repair.\textsuperscript{20}

A meta-analysis evaluated seven studies that compared EVAR and open repair in patients with ruptured AAA (n=463).\textsuperscript{10} The literature was searched until 31 July 2007, and it is unclear as to the types of study designs included. The time spent in intensive care was significantly shorter with EVAR compared with open repair. There was also a significant reduction in 30-day mortality with EVAR. No reductions in post-operative length of stay and complications were seen.

Two cost-effectiveness studies comparing emergency EVAR to emergency open repair were found.\textsuperscript{21,22} A preferential emergency EVAR protocol for ruptured AAAs can decrease mortality but does not increase overall direct medical costs as compared to emergency open repair-only protocol.\textsuperscript{21} When one-year follow-up costs were added to total in-hospital costs, the costs were lower with emergency EVAR than emergency open repair.\textsuperscript{22}

**CONCLUSIONS AND IMPLICATIONS FOR DECISION MAKING:**

In elective patients with AAAs $\geq 5.5$ cm, meta-analyses of four RCTs provided evidence that EVAR reduces 30-day all-cause mortality and length of hospital stay, but not mid-term (4 years) mortality. Other meta-analyses that included non-RCTs also found benefits with EVAR but these are subject to bias which leads to caution in interpretation of the findings. Economic analyses showed that EVAR have a higher cost per QALY compared with open surgery.

In emergency patients, EVAR also shows clinical benefits and appears to be cost-effective compared to open repair, but RCTs are required to confirm these findings.
REFERENCES:


