Perceived barriers to endovascular repair of ruptured abdominal aortic aneurysm among Australasian vascular surgeons

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Editorial Team

We are submitting our manuscript ‘Perceived barriers to endovascular repair of ruptured abdominal aortic aneurysm among Australasian vascular surgeons’ for consideration of publication in your journal.

All authors have read and approve of the submitted content of the manuscript. No portion of the paper has previously been published or currently under consideration elsewhere. No financial arrangement, commercial association or other relationship that could be construed as a conflict of interest has been obtained in order to complete this work. No patents have been submitted relevant to this work. No company products pertaining to abdominal aortic aneurysm surgery are mentioned in this manuscript.
We are prepared to upload the survey and data to a repository such as ResearchGate if the paper is accepted.

We strongly encourage the opportunity to discuss our manuscript.

Yours sincerely,

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Abstract

Objective: While endovascular aneurysm repair (EVAR) of abdominal aortic aneurysm (AAA) is widely accepted for elective surgery, its uptake in emergency ruptured AAA has trailed behind. This study was intended to identify the barriers to widespread application of emergent EVAR in Australia and New Zealand.

Methods: A cross-sectional survey of members of the Australia and New Zealand Society of Vascular Surgeons was performed in late 2013. Primary themes explored were: i) perceived barriers to performing emergent EVAR; and ii) advantages of emergent EVAR compared with open repair (OR). Secondary data measures were the volume of AAA surgery, standard protocol use and staff accreditation among vascular units.

Results: 85 surgeons responded to an anonymous online questionnaire (41% response rate). 23 surgeons (27%) had no experience with emergent EVAR. 65% currently perform more EVAR than OR for elective procedures, compared with 18% for ruptured AAA. Of the perceived barriers explored, respondents agreed that poor availability of endovascular facilities (73% agreed or strongly agreed) and ancillary staff (56%) were barriers to emergent EVAR. A majority of surgeons agreed that the advantages of emergent EVAR include
reduced intraoperative blood loss, length of stay and post-operative complications. Among 11 vascular units performing emergent EVAR, four had standard protocols in use and four had mandatory staff accreditation.

**Conclusion:** The most common barrier to emergent EVAR identified by surgeons was the poor availability of endovascular facilities, many of which are not ideally suited for this type of procedure. Australian and New Zealand vascular units have low rates of standard protocol use and staff accreditation for emergent EVAR, which may have implications for patient care.

**Key words:** aortic rupture, endovascular aneurysm repair, emergent procedure, questionnaire, trends.
**Introduction**

Advances in surgical technique and intensive care medicine have improved the operative mortality rate for elective, non-ruptured, surgical treatment of abdominal aortic aneurysm (AAA) over the last two decades.\(^1\),\(^2\) One important factor has been the uptake of minimally invasive, endovascular aneurysm repair (EVAR).\(^3\) Despite these advances, many institutions have not experienced improved outcomes for ruptured AAA,\(^4\),\(^5\),\(^6\) with a reported in-hospital mortality rate of 40\(^\%\)\(^6\),\(^7\) and overall mortality rate of 80\(^\%\).\(^8\) EVAR for ruptured AAA (so-called r-EVAR) has been successfully performed using a variety of protocols and techniques,\(^9\)\(^-\)\(^12\) and may offer an alternative to conventional open repair in selected patients when it can be technically and logistically performed.

A number of centres have successfully adopted emergent EVAR with the use of trained interdisciplinary teams,\(^13\) and standardised operating procedures and protocols\(^14\) that consider the logistics of prehospital and in-hospital treatment. However, the uptake of emergent EVAR amongst Australian and New Zealand institutions has not been widespread (Table I).\(^15\) Having identified a large volume of endovascular experience and enthusiasm among Australasian surgeons,\(^16\) we chose to explore which barriers have hindered the widespread application of emergent EVAR. We set out to determine current experience with and perceived barriers to emergent EVAR, focusing on issues pertaining to anatomy, techniques and in-hospital logistics. In addition, we investigated the implementation of standard protocols and mandatory training for emergent EVAR.
Methods

Study design and sample

A survey was developed from anatomical, technical and in-hospital logistical issues of emergent EVAR that were cited in the literature. Questions relating to the advantages of emergent EVAR were generalised from elective EVAR trials. The survey was formatted and administered using SurveyMonkey© (Palo Alto, CA, USA). The study sample was current practicing and non-trainee members of the Australia and New Zealand Society of Vascular Surgeons (ANZSVS). ANZSVS advises the Royal Australasian College of Surgeons on quality and standards in vascular surgery. This study was approved by the Austin Hospital Human Research and Ethics Committee (LNR/13/Austin/146) and the executive committee of ANZSVS. Before commencing the survey, respondents were asked to agree to a consent statement outlining the purpose and nature of the study. The survey was conducted over 6 weeks in 2013. Neither email nor IP address of respondents was recorded.

Survey measures and data analysis

The primary measures were: i) perceived barriers to performing emergent EVAR; and ii) perceived advantages to performing emergent EVAR compared with OR. Each category was rated on a 5-point Likert scale where 1 indicated ‘strongly agree’ and 5 indicated ‘strongly disagree’. Surgeons could list additional barriers to EVAR at their discretion. We also asked respondents about their estimated career and annual (from the preceding year) volumes of AAA surgery. Respondents identifying themselves as a Head of Unit (HOU) were asked additional questions on staff accreditation and the use of formal protocols.
The study sample and survey response were described with standard frequency analyses.

Missing responses to an item were excluded from analysis.
Results

Eighty-five of 208 members of the ANZSVS responded to our survey (41% response rate). Thirty-two respondents had 20 or more years (38%) of specialist experience and 28 had less than 10 years of experience (33%). Fifteen surgeons identified as being a HOU.

Emergent EVAR experience

Career and annual volume of AAA repairs are shown in Table II. Of the 85 respondents, 11 (13%) had no experience with elective EVAR whilst 23 (27%) had no experience with emergent EVAR. Fifty-five surgeons (65%) performed more EVAR than OR for elective AAA in the preceding year. Only 15 surgeons (18%) performed more EVAR than OR for ruptured AAA in the preceding year.

Surgeons with 10–19 years of specialist experience had performed the most emergent EVAR procedures (an average of nine procedures each). This was followed by surgeons with 20 or more years of experience (an average of five procedures each) and those with less than 10 years of experience (an average of four procedures each). Surgeons performing emergent EVAR were most likely to do so in an angiography suite (49 of 62 surgeons), followed by conventional or hybrid theatres (32 surgeons apiece).

Perceived barriers to emergent EVAR

A majority of respondents felt the unavailability of endovascular facilities (73% agreed or strongly agreed) and ancillary staff (56%) were barriers to emergent EVAR (Fig 1). Most
respondents disagreed that an impaired ability to convert to an open repair (62% disagreed or strongly disagreed), lack of personal experience (64%), cost or the need for long-term follow-up (69%) and lack of device company support (69%) were barriers to emergent EVAR (Fig 1). There was uncertainty among respondents as to whether the availability of onsite stents, patient anatomy, transfer time, or the need for computed tomography represented barriers to emergent EVAR.

Other barriers to emergent EVAR that were nominated by surgeons included poorly trained radiography staff or a lack of radiography staff for after-hours surgery (three surgeons). A number of surgeons reported inadequate endovascular facilities that included poor imaging equipment in standard operating theatres (two surgeons), an absence of a hybrid theatre (five surgeons) or a lack of anaesthetic equipment in the angiography suite (two surgeons). Three surgeons cited institutional and/or inter-departmental resistance to an on-call EVAR roster as a notable barrier.

**Advantages of emergent EVAR**

More than 75% of surgeons’ agreed (or strongly agreed) that emergent EVAR reduced intraoperative blood loss, the length of stay and the frequency of post-operative complications (Fig 2). Sixty-eight respondents (80%) agreed that emergent EVAR would be part of their future practice.

**Heads’ of unit perspective**
Fifteen surgeons identifying as a HOU responded to our survey. Of these, 11 oversee vascular units that perform emergent EVAR for ruptured AAA, of which seven (64%) were based at tertiary centres. Four Units (36%) reported standard protocol use, and four (36%) had mandatory staff accreditation.
**Discussion**

Well-designed randomised trials have demonstrated that EVAR for elective, non-ruptured AAA has lower perioperative mortality rates than OR, along with a reduced length of stay, lower operative time, and decreased blood loss. Consequently, EVAR should be considered for all patients suitable for an elective AAA repair, though other factors may temper this decision including aneurysm morphology, patient age, and follow-up requirements.

Evidence to date favouring emergent EVAR has been less convincing. The Amsterdam Acute Aneurysm trial and the Immediate Management of the Patient with Rupture: Open vs Endovascular Repair (IMPROVE) trial have been the only randomized controlled trials to date. Results have shown no significant improvement in combined death or severe complications compared with OR at 30 days follow-up. The outcomes for haemodynamically unstable patients who have been predicted to gain most benefit from EVAR were not assessed in these trials. Whilst observational studies have revealed improved mortality outcomes for emergent EVAR, including for unstable, and risk-stratified patients, these studies have been confounded by small sample sizes, significant selection bias and a lack of uniform inclusion criteria. Two potential drawbacks of emergent EVAR identified from these studies have been high rates of abdominal compartment syndrome and reintervention for endoleak or graft migration (up to 23% in one study).

Eighty-seven percent of Australian and New Zealand vascular surgeons who responded to our survey had performed elective EVAR. This result is similar to a survey of UK vascular surgeons (84% performing EVAR) and to another survey of a younger (age <50 years)
cohort of US surgeons that showed 89% perform a majority of their workload by endovascular technique.\textsuperscript{22} As expected, emergent EVAR experience was low and was greatly exceeded by emergent OR experience.

\textit{Feasibility}

At present, approximately half of all patients presenting with ruptured AAA could feasibly undergo EVAR based on their anatomical profile.\textsuperscript{9,12} The primary reason for not performing EVAR is unsuitable infrarenal neck anatomy (absent, very short or very wide necks).\textsuperscript{12} We found that surgeons have considerable uncertainty about patients’ anatomical suitability for emergent EVAR. It is expected that in time an increasing proportion of patients will be suitable for emergent EVAR because of improvements in technical experience and advances in graft conformation to adverse anatomy and secure fixation.\textsuperscript{18} This optimism is exemplified by 80\% of surgeons in the present study agreeing that emergent EVAR would be part of their future practice, including 12 surgeons with no experience to date.

\textit{Technical and logistical barriers}

A majority of surgeons reported that a lack of available endovascular facilities presented a substantial barrier to performing emergent EVAR. In the Australasian setting most EVARs are performed in the radiology angiography suite. A minority of cases are performed in an operating theatre with a mobile C-arm, which lack the image quality for complex procedures\textsuperscript{23} and the mobility of specialised fluoroscopy suites. Few institutions have access to a dedicated endovascular suite or ‘hybrid theatre’, which have up-to-date fixed-imaging
fluoroscopy in a room equipped for all aspects of an OR and EVAR. In a survey of UK surgeons, more than one third did not have access to after-hours endovascular facilities.

A number of surgeons in the present study cited the inadequacy of facilities as a significant barrier. This included an angiography suite lacking appropriate anaesthetic equipment and potentially necessitating theatre transfer for conversion to an OR. A retrospective analysis of elective EVAR showed that hybrid theatres were more efficient and were less likely to expose patients to harmful contrast than standard operating theatres; however, studies have not specifically considered the cost and effectiveness of performing emergent EVAR in such theatres. While experience with hybrid theatres was not purposely explored in the present study, a number of surgeons did nominate an absence of hybrid theatres as a notable barrier.

For haemodynamically stable patients, CT is commonly performed to confirm AAA rupture, assess anatomical suitability and to select an appropriate stent-graft. For unstable or unconscious patients requiring immediate aortic repair, CT can be omitted with device selection based on intraoperative angiography, usually allowing for adequate stent-graft oversizing. Whilst several recent studies have shown that CT imaging can be obtained within 10–15 minutes and without delay to treatment, this has yet to be confirmed for unstable patients or in peripheral settings. Another important consideration is the risk of contrast nephropathy, particularly when both CT and procedural angiography are performed on critically ill patients in hypovolaemic shock.

Distinct to OR, EVAR for ruptured AAA requires a readily available multidisciplinary team of proceduralists, anaesthetists, transport personnel and procedural nurses skilled in both OR and EVAR. Implementing an emergent EVAR program is a complex process, particularly for
24-hour per day coverage. This requires a dedicated operating room managed by appropriately trained staff with access to an on-site inventory of preferred and common stent-graft components. A standard protocol consisting of a multidisciplinary algorithm has been shown to enable an efficient transition of patient care from the emergency department, imaging services and on to the vascular surgery team and operating room staff. In addition, centralisation of aneurysm care to dedicated hospitals of expertise has been shown to have much lower perioperative mortality rates for emergent EVAR and OR when compared with historical data of ruptured AAA patients. We found low overall rates of standard protocol use and staff accreditation for emergent EVAR in Australian and New Zealand centres. One possible explanation is the absence of regional guidelines and considerable ambiguity amongst international vascular societies in regards to patient selection, anatomical and graft suitability, and the need for routine pre-operative CT.

The results of this study should be interpreted in light of a moderate response rate (41%). Surgeons’ caseloads were self-reported and verification with logbooks or healthcare data may increase accuracy. Because of the training role of ANZSVS and the high skill level required to perform EVAR, we have high confidence that all suitable surgeons within Australia and New Zealand were approached to participate in this study. We expect the role of emergent EVAR will be further defined by the publication of a forthcoming randomized study on perioperative mortality, and the longer-term results of patients enrolled in the two major trials to date. Useful adjuncts to the present study would be investigating barriers to EVAR perceived by other multidisciplinary staff, as well as the experience and opinions of interventional radiologists. In addition, further work could confirm the role of centralization for emergent EVAR, as this has implications for rural and regional populations in Australia and New Zealand, where there are important differences in incidence and outcomes for AAA.
ruptures. The ability to perform prompt and high-quality CT scans in peripheral centres would also need to be assessed before emergent EVAR can be widely adopted. Finally, linking the Australasian Vascular Audit to state or local-based registries may provide useful morbidity and mortality trends for emergent EVAR.
Conclusion

A lack of available endovascular facilities was the most agreed upon barrier to emergent EVAR for current practicing Australasian vascular surgeons. Surgeons also reported that current endovascular facilities are not ideally suited for emergent EVAR. Australian and New Zealand vascular units have low rates of standard protocol use and staff accreditation for emergent EVAR, which may have implications for the care of patients presenting with ruptured AAA.

Acknowledgements

Thank you to the staff and members of ANZSVS.
References:


Figure 2

- Reduced intraop blood loss
- Reduced length of stay
- Reduced complications
- Shorter procedure time

Legend:
- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree
Table I. Number of AAA Repairs Reported in the Australasian Vascular Audit in 2013.\textsuperscript{15} The construct of the audit has previously been reported by Beiles et al.\textsuperscript{16}

<table>
<thead>
<tr>
<th>AAA type</th>
<th>Open repair</th>
<th>EVAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intact</td>
<td>613 (29.5)</td>
<td>1466 (70.5)</td>
</tr>
<tr>
<td>Ruptured</td>
<td>227 (71.8)</td>
<td>64 (28.2)</td>
</tr>
</tbody>
</table>
Table II. Self-reported Career and Annual Volumes of AAA Repairs

<table>
<thead>
<tr>
<th>Repair type</th>
<th>Career Volume</th>
<th></th>
<th>Annual Volume</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Range</td>
<td>Mean (SD)</td>
<td>Range</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td>All Repairs</td>
<td>0 - 1200</td>
<td>372 (256)</td>
<td>0 - 100</td>
<td>23 (14)</td>
</tr>
<tr>
<td>Elective, OR</td>
<td>0 - 1200</td>
<td>214 (185)</td>
<td>0 - 50</td>
<td>7 (6)</td>
</tr>
<tr>
<td>Elective, EVAR</td>
<td>0 - 450</td>
<td>107 (96)</td>
<td>0 - 50</td>
<td>13 (9)</td>
</tr>
<tr>
<td>Emergent, OR</td>
<td>0 - 200</td>
<td>60 (45)</td>
<td>0 - 8</td>
<td>3 (2)</td>
</tr>
<tr>
<td>Emergent, EVAR</td>
<td>0 - 25</td>
<td>6 (5)</td>
<td>0 - 6</td>
<td>1</td>
</tr>
</tbody>
</table>

SD: standard deviation
**Fig 1.** Surgeons’ responses to potential barriers of performing emergent EVAR.

CT, computed tomography.

**Fig 2.** Surgeons’ responses to the potential advantages of EVAR compared with OR for ruptured AAA.
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