Modern Management of Ruptured Abdominal Aortic Aneurysms In The Endovascular Era: What Have We Learned?

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The Alexander Whitehill Clowes Endowed Chair of Vascular Surgery
Professor and Chief;
Division of Vascular Surgery
University of Washington
Seattle, WA
Disclosures

• AORTICA CORPORATION: Co-Founder
Previous Sommer Lectures in Vascular Surgery

- 1948 Dr. Herman Pearse
- 1956 Dr. Alfred Blalock
- 1957 Dr. Robert Linton
- 1960 Dr. Michael DeBakey
- 1967 Dr. Charles Rob
- 1974 Dr. David Sabiston
- 1975 Dr. Arthur Beall
- 1982 Dr. Kurt Amplatz
- 1999 Dr. Jerry Goldstone

Dr. Ernst Sommer
1869-1936
“There is no disease more conducive to clinical humility than aneurysm of the aorta.”
Why do we fix aortic aneurysms?

- *To prevent death due to rupture*
Ruptured Aortic Aneurysms

• Overall Mortality 85% (95% CI 80-91)
  – 66% die before reaching hospital or without operation


• Peri-operative mortality open repair 41-48%


• Mortality after open repair of rAAA has not improved significantly in the past 20 years
Harborview Medical Center
30-40 rAAA per year

Ruptured AAA Harborview 2002-2013
N=431
Ruptured abdominal aortic aneurysm: The Harborview experience

Kaj Johansen, MD, PhD, Ted R. Kohler, MD, Stephen C. Nicholls, MD, R. Eugene Zierler, MD, Alexander W. Clowes, MD, and Andris Kazmers, MD, Seattle, Wash.

During the last decade (1980 to 1989) 186 patients with ruptured abdominal aortic aneurysm were admitted to a single urban hospital. Ninety-six percent of these patients had a prehospital systolic blood pressure <90 mm Hg. Management included paramedic field resuscitation and transport, an emergency department diagnostic protocol completed in an average of 12 minutes, rapid transport to a dedicated emergency operating room, aneurysmorrhaphy by general surgery chief residents under the supervision of specialist vascular surgeons, and skilled postoperative intensive care unit care. Nevertheless, 130 (70%) patients died in the first 30 postoperative days—3% in the emergency department, 13% in the operating room, 51% in the intensive care unit, and 3% on the ward or at home. Certain features—age >80 years, female gender, persistent preoperative hypotension despite aggressive crystalloid and blood replacement, admission hematocrit <25, transfusion requirements exceeding 15 units—were associated with a >90% likelihood of death. No patient with preoperative cardiac arrest survived more than 24 hours. From this experience we conclude that, although “optimal” prehospital, emergency department, operating room, and postoperative care can improve the outcome of patients with ruptured abdominal aortic aneurysms in shock, most such patients will die. Certain clinical features predict such excessive mortality rates after ruptured abdominal aortic aneurysms that withholding operation may be reasonable. Screening of patients at high risk for abdominal aortic aneurysm, followed by elective aneurysmorrhaphy, is clearly indicated. (J Vasc Surg 1991;13:240-7.)
Johansen et al.

- 1980-1989
- 186 patients
  - 96% had pre-hospital SBP < 90 mmHg
  - 70% Mortality
  - 3% in ER
  - 13% in OR
  - 51% in ICU
  - 3% on ward / at home
Johansen et al., 1991

Factors associated with >90% likelihood of death:
- Age > 80
- Female
- HCT < 25%
- Transfusion > 15U
- No patient with CPR survived > 24hrs

May include the use of the MAST suit, and possibly, as Dr. Holcroft of Sacramento and others are suggesting, of hypertonic saline as a resuscitation fluid before arrival at the hospital.

The crucial aspect of the initial part of the operation is gaining proximal control of the aorta. As a consequence, although this operation is performed by the general surgery chief resident, the attending surgeon is the one who gains proximal aortic control and ultimately places the aortic clamp. Note, however, that despite this we report a substantial incidence of iatrogenic venous injury with this ma...
Clamp Before You Cut: Proximal Aortic Control with Balloon Occlusion

CPT Zachary Arthurs MD,
CPT Craig See MD,
COL(R) Charles Anderson MD, and
LTC Benjamin Starnes MD

Vascular and Endovascular Surgery Service
Madigan Army Medical Center
Tacoma, Washington

2002
Table 1. Baseline Characteristics of Medicare Beneficiaries Undergoing Endovascular or Open Repair for Aortic Aneurysms in the 2001–2004 Period, before and after Selection by a Matched Propensity Score Method.

### Unmatched Cohort

<table>
<thead>
<tr>
<th>Variable</th>
<th>Endovascular Repair (N = 29,542)</th>
<th>Open Repair (N = 32,056)</th>
<th>P Value</th>
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</thead>
<tbody>
<tr>
<td>Male sex</td>
<td>83.2</td>
<td>82.6</td>
<td>0.01</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>67–69 yr</td>
<td>11.9</td>
<td>13.1</td>
<td></td>
</tr>
<tr>
<td>70–74 yr</td>
<td>26.8</td>
<td>24.6</td>
<td></td>
</tr>
<tr>
<td>75–79 yr</td>
<td>35.7</td>
<td>34.0</td>
<td></td>
</tr>
<tr>
<td>80–84 yr</td>
<td>15.8</td>
<td>13.5</td>
<td></td>
</tr>
<tr>
<td>≥85 yr</td>
<td>9.8</td>
<td>7.1</td>
<td></td>
</tr>
<tr>
<td>Race or ethnic group*</td>
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<tr>
<td>White</td>
<td>95.8</td>
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<tr>
<td>Black</td>
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<td>Hispanic</td>
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<td></td>
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<tr>
<td>Other</td>
<td>1.1</td>
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</tr>
<tr>
<td>Urgent admission</td>
<td>2.5</td>
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<tr>
<td>Previous diagnosis of abdominal aortic aneurysm within the past 6 months</td>
<td>76.3</td>
<td>73.4</td>
<td>0.01</td>
</tr>
<tr>
<td>Coexisting conditions</td>
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<tr>
<td>Myocardial infarction within the past 6 mo</td>
<td>1.9</td>
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</tr>
<tr>
<td>Myocardial infarction within the past 7–24 mo</td>
<td>9.1</td>
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<td>Valvular heart disease</td>
<td>12.2</td>
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<tr>
<td>Congestive heart failure</td>
<td>16.1</td>
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<td></td>
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<tr>
<td>Peripheral vascular disease</td>
<td>21.2</td>
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<td></td>
</tr>
<tr>
<td>Cerebrovascular disease</td>
<td>16.1</td>
<td></td>
<td></td>
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<tr>
<td>Hypertension</td>
<td>67.1</td>
<td>65.9</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>17.8</td>
<td>14.3</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Chronic obstructive pulmonary disease</td>
<td>30.8</td>
<td>26.9</td>
<td>&lt;0.001</td>
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<tr>
<td>Renal disease</td>
<td>8.0</td>
<td>4.4</td>
<td>0.005</td>
</tr>
<tr>
<td>End-stage renal disease</td>
<td>0.6</td>
<td>0.3</td>
<td>0.001</td>
</tr>
<tr>
<td>History of cancer</td>
<td>23.6</td>
<td>18.2</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Obesity</td>
<td>2.4</td>
<td>1.6</td>
<td>0.001</td>
</tr>
</tbody>
</table>

* Race or ethnic group was self-reported.
## Table 2. Perioperative Outcomes after Endovascular Repair or Open Repair

<table>
<thead>
<tr>
<th>Perioperative Outcome</th>
<th>Endovascular Repair (N = 22,830)</th>
<th>Open Repair (N = 22,830)</th>
<th>P Value</th>
<th>Relative Risk Associated with Open Repair (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Death (% of patients)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All ages</td>
<td>1.2</td>
<td>4.8</td>
<td>&lt;0.001</td>
<td>4.00 (3.51-4.56)</td>
</tr>
<tr>
<td>67–69 yr</td>
<td>0.4</td>
<td>2.5</td>
<td>&lt;0.001</td>
<td>6.21 (4.98-7.73)</td>
</tr>
<tr>
<td>70–74 yr</td>
<td>0.8</td>
<td>3.3</td>
<td>&lt;0.001</td>
<td>4.12 (3.51-4.84)</td>
</tr>
<tr>
<td>75–79 yr</td>
<td>1.3</td>
<td>4.8</td>
<td>&lt;0.001</td>
<td>3.69 (3.25-4.19)</td>
</tr>
<tr>
<td>80–84 yr</td>
<td>1.6</td>
<td>7.2</td>
<td>&lt;0.001</td>
<td>4.49 (4.02-5.02)</td>
</tr>
<tr>
<td>≥85 yr</td>
<td>2.7</td>
<td>11.2</td>
<td>&lt;0.001</td>
<td>4.14 (3.80-4.52)</td>
</tr>
<tr>
<td><strong>Medical complications (% of patients)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Myocardial infarction</td>
<td>7.0</td>
<td>9.4</td>
<td>&lt;0.001</td>
<td>1.34 (1.26-1.42)</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>9.3</td>
<td>17.4</td>
<td>&lt;0.001</td>
<td>1.89 (1.79-1.98)</td>
</tr>
<tr>
<td>Acute renal failure</td>
<td>5.5</td>
<td>10.9</td>
<td>&lt;0.001</td>
<td>2.00 (1.87-2.14)</td>
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<tr>
<td>Renal failure requiring dialysis</td>
<td>0.4</td>
<td>0.5</td>
<td>0.047</td>
<td>1.33 (1.00-1.75)</td>
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<tr>
<td>Deep-vein thrombosis or pulmonary embolism</td>
<td>1.1</td>
<td>1.7</td>
<td>&lt;0.001</td>
<td>1.51 (1.29-1.76)</td>
</tr>
<tr>
<td><strong>Surgical complications (% of patients)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conversion to open repair</td>
<td>1.6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acute mesenteric ischemia</td>
<td>1.0</td>
<td>2.1</td>
<td>&lt;0.001</td>
<td>2.19 (1.87-2.56)</td>
</tr>
<tr>
<td>Reintervention for bleeding</td>
<td>0.8</td>
<td>1.2</td>
<td>&lt;0.001</td>
<td>1.50 (1.24-1.80)</td>
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<tr>
<td>Tracheostomy</td>
<td>0.2</td>
<td>1.5</td>
<td>&lt;0.001</td>
<td>7.46 (5.48-10.14)</td>
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<tr>
<td>Thrombectomy</td>
<td>0.4</td>
<td>0.2</td>
<td>&lt;0.001</td>
<td>0.50 (0.35-0.71)</td>
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<tr>
<td>Embolectomy</td>
<td>1.3</td>
<td>1.7</td>
<td>&lt;0.001</td>
<td>1.29 (1.11-1.50)</td>
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<tr>
<td>Repair of infected graft or graft-enteric fistula</td>
<td>0.01</td>
<td>0.09</td>
<td>&lt;0.001</td>
<td>7.00 (2.09-23.46)</td>
</tr>
<tr>
<td>Major amputation</td>
<td>0.04</td>
<td>0.13</td>
<td>0.002</td>
<td>3.00 (1.47-6.14)</td>
</tr>
<tr>
<td>Complications related to laparotomy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lysis of adhesions without resection</td>
<td>0.1</td>
<td>1.2</td>
<td>&lt;0.001</td>
<td>13.05 (8.37-20.33)</td>
</tr>
<tr>
<td>Bowel resection</td>
<td>0.6</td>
<td>1.3</td>
<td>&lt;0.001</td>
<td>2.17 (1.77-2.65)</td>
</tr>
<tr>
<td>Ileus or bowel obstruction without resection</td>
<td>5.1</td>
<td>16.7</td>
<td>&lt;0.001</td>
<td>3.25 (3.05-3.46)</td>
</tr>
<tr>
<td>Mean length of hospital stay (no. of days)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All ages</td>
<td>3.6 ± 0.7</td>
<td>9.3 ± 1.5</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>67–69 yr</td>
<td>94.5</td>
<td>81.6</td>
<td>&lt;0.001</td>
<td>0.87 (0.87-0.88)</td>
</tr>
<tr>
<td>70–74 yr</td>
<td>97.8</td>
<td>92.6</td>
<td>&lt;0.001</td>
<td>0.95 (0.95-0.95)</td>
</tr>
<tr>
<td>75–79 yr</td>
<td>96.8</td>
<td>88.7</td>
<td>&lt;0.001</td>
<td>0.92 (0.91-0.92)</td>
</tr>
<tr>
<td>80–84 yr</td>
<td>94.4</td>
<td>80.4</td>
<td>&lt;0.001</td>
<td>0.83 (0.84-0.86)</td>
</tr>
<tr>
<td>≥85 yr</td>
<td>90.6</td>
<td>67.7</td>
<td>&lt;0.001</td>
<td>0.75 (0.74-0.75)</td>
</tr>
<tr>
<td><strong>Discharged home (% of survivors)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All ages</td>
<td>94.5</td>
<td>81.6</td>
<td>&lt;0.001</td>
<td>0.87 (0.87-0.88)</td>
</tr>
<tr>
<td>67–69 yr</td>
<td>97.8</td>
<td>92.6</td>
<td>&lt;0.001</td>
<td>0.95 (0.95-0.95)</td>
</tr>
<tr>
<td>70–74 yr</td>
<td>96.8</td>
<td>88.7</td>
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<td>94.4</td>
<td>80.4</td>
<td>&lt;0.001</td>
<td>0.83 (0.84-0.86)</td>
</tr>
<tr>
<td>80–84 yr</td>
<td>90.6</td>
<td>67.7</td>
<td>&lt;0.001</td>
<td>0.75 (0.74-0.75)</td>
</tr>
<tr>
<td>≥85 yr</td>
<td>84.6</td>
<td>57.1</td>
<td>&lt;0.001</td>
<td>0.67 (0.66-0.68)</td>
</tr>
</tbody>
</table>

* Plus-minus values are means ±SD.
What about EVAR for Rupture?
Endovascular Repair of Ruptured Aortic Aneurysms

- Published mortality rates after REVAR
  - 24 to 46%

EVIDENCE SUMMARY

Jan D. Blankensteijn, MD, Section Editor

Endovascular repair of ruptured abdominal aortic aneurysm: A strategy in need of definitive evidence

Robert J. Hinchliffe, MD, MRCS, Janet T. Powell, PhD, FRCPath, Nicholas J. Cheshire, MD, FRCS, and Matthew M. Thompson, MD, FRCS, London, United Kingdom

Introduction: Endovascular strategies have been increasingly used to manage patients with ruptured abdominal aortic aneurysm (AAA) in an attempt to improve patient survival. We analyzed the evidence to support such an approach.

Methods: We performed a systematic literature review of endovascular aneurysm repair (EVAR) of ruptured AAA from 1994 to 2009. The literature analyzed included systematic reviews and population-based studies of ruptured AAA.

Results: Seven systematic reviews were identified, all demonstrating from published data that patients with EVAR of ruptured AAA had significantly reduced mortality compared with controls. Six recently published population-based studies from the United States demonstrated low mortality rates associated with EVAR; however, only a small proportion of ruptured AAAs were treated by EVAR. Systematic reviews and population-based studies both raised concerns about patient selection and publication bias. Two randomized trials are in progress, and one is due to commence 2009.

Conclusions: The outcome of EVAR in a nonselected patient population remains unknown. One or more definitive randomized trials could provide the level I evidence to resolve these issues. (J Vasc Surg 2009;49:1077-80.)
Table I. Data from published series from 1994 to 2009 where outcomes of endovascular repair for ruptured abdominal aortic aneurysms were compared with a control group undergoing open surgery.

<table>
<thead>
<tr>
<th>First author</th>
<th>Year</th>
<th>Study type</th>
<th>Patients treated by EVAR, No.</th>
<th>30-day mortality, %</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>EVAR</td>
<td>Open repair</td>
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<tr>
<td>Acosta</td>
<td>2007</td>
<td>Retrospective review</td>
<td>56</td>
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<td>45</td>
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<tr>
<td>Alsac</td>
<td>2005</td>
<td>Case series</td>
<td>17</td>
<td>23.5</td>
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<tr>
<td>Anain</td>
<td>2007</td>
<td>Retrospective review</td>
<td>30</td>
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<td>Arya</td>
<td>2006</td>
<td>Prospective intent-to-treat</td>
<td>17</td>
<td>24</td>
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<td>2005</td>
<td>Retrospective review</td>
<td>11</td>
<td>0</td>
<td>15</td>
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<td>Retrospective review</td>
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<td>Coppi</td>
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<td>33</td>
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<td>Prospective observation</td>
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<td>Moore</td>
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<td>Prospective observation</td>
<td>20</td>
<td>5</td>
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<td>Najjer</td>
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<td>6.7</td>
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<td>Ohki</td>
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<td>Retrospective study</td>
<td>18</td>
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<td>29</td>
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<td>Wibmer*</td>
<td>2008</td>
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<td>25*</td>
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<td>Retrospective review</td>
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<td>49</td>
<td>35</td>
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<tr>
<td>Verhoeven</td>
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<td>Prospective observation</td>
<td>36</td>
<td>28.1</td>
<td>13.9</td>
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<td>Sadat</td>
<td>2009</td>
<td>Prospective observation</td>
<td>17</td>
<td>6</td>
<td>17</td>
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EVAR, Endovascular aneurysm repair; NS, not significant.
*90 day mortality figures quoted.
<table>
<thead>
<tr>
<th>First author</th>
<th>Study period</th>
<th>Population</th>
<th>No. (relative %)</th>
<th>Mortality, %</th>
</tr>
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<tr>
<td></td>
<td></td>
<td></td>
<td>EVAR</td>
<td>Open</td>
</tr>
<tr>
<td>Greco⁴</td>
<td>2000-2003</td>
<td>Calif, Fla, NJ, NY⁵</td>
<td>290 (5)</td>
<td>5508 (95)</td>
</tr>
<tr>
<td>Lesperance⁴</td>
<td>2001-2004</td>
<td>US (NIS)</td>
<td>949 (10)</td>
<td>8982 (90)</td>
</tr>
<tr>
<td>Egorova²</td>
<td>1995-2004</td>
<td>US (Medicare)</td>
<td>1064 (2.5)</td>
<td>41969 (97.5)</td>
</tr>
<tr>
<td>Giles⁵</td>
<td>1993-2005ᵇ</td>
<td>US (NIS)</td>
<td>2499 (10.7)</td>
<td>20836 (89.3)</td>
</tr>
<tr>
<td>McPhee⁶</td>
<td>2001-2006</td>
<td>US (NIS)</td>
<td>3179 (11.5)</td>
<td>24571 (88.5)</td>
</tr>
<tr>
<td>Vogel⁷</td>
<td>2001-2005</td>
<td>NJ⁸</td>
<td>82 (12)</td>
<td>618 (88)</td>
</tr>
</tbody>
</table>

LVC, Low-volume center; HVC, high-volume center; NIS, Nationwide Inpatient Sample.

*State-based data sets.

ᵇComparative subset 2001-2005.

*State Inpatient Databases.
rAAA

Hemodynamically Stable
Mentating
SBP >80mmHg

CTA

Operating Room
Prepped Awake
Permissive Hypotension

12 Fr Sheath and AOB +/- Preclose
+/- Angio and/or IVUS

Unsuitable Anatomy
AOB
GETA and Open Repair

Suitable Anatomy
Awake
EVAR

Hemodynamically Unstable
Not Mentating
SBP <80mmHg

Mehta et al JVS 2006;44:1-8
Dramatic Example:

- September 22, 2008
- 79 yo male- acute onset of abdominal and LB pain. Family called 911
- Medic One- Hypotensive SBP 70 in field- fluid responsive
- On arrival; HR 90, SBP 92, Temp 37.2
- CTA
12.0cm Aorto-Iliac Aneurysm
<table>
<thead>
<tr>
<th>OUT-FLU</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Urine Output</td>
<td>100</td>
<td>20</td>
<td>300 mL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Estimated Blood Loss</td>
<td>50</td>
<td>50</td>
<td>125 mL</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>DATA</td>
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<td></td>
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<tr>
<td>SaO2-SAT</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100 %</td>
<td></td>
</tr>
<tr>
<td>Agent=</td>
<td>SEV</td>
<td>SEV</td>
<td>SEV</td>
<td>SEV</td>
<td>SEV</td>
<td>SEV</td>
<td>SEV</td>
<td>SEV</td>
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<td>SEV</td>
<td>SEV</td>
<td>SEV</td>
</tr>
<tr>
<td>Tidal Volume</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>ml</td>
</tr>
</tbody>
</table>

**Graph:***
- ECG Rate
- Arterial BP Sys 1
- Arterial BP Dia 1
- Arterial BP Mean 1
- NIBP Sys
- NIBP Dia
- NIBP Mean
- Respiratory Rate
Mortality 2012

- Overall mortality in 2012: 57.8%
- REVAR protocol mortality in 2012: 25.3%
- Mortality in 2012: 16.3%

Statistical significance: P < 0.001
What Have We Learned?

\[ rA^3 \]
Expanding use of emergency endovascular repair for ruptured abdominal aortic aneurysms: Disparities in outcomes from a nationwide perspective

Kelly Lesperance, MD, Charles Andersen, MD, Niten Singh, MD, Benjamin Starnes, MD, and Matthew J. Martin, MD, Tacoma, Wash

Background: Endovascular repair (EVAR) of abdominal aortic aneurysms (AAA) has become widely accepted in the elective setting but remains controversial for emergency repair of ruptured aneurysms (rAAA). We sought to examine the national trends in use and associated outcomes with EVAR.

Methods: The Nationwide Inpatient Sample (NIS) was used to analyze all admissions for rAAA from 2001 through 2004. Nationwide temporal trends and demographics using weighted samples were evaluated. Focused univariate and multivariate analyses comparing outcomes from open repair and EVAR were done for the years 2003 and 2004.

Results: There were 28,123 admissions for rAAA, with a stepwise decline in admissions from 2001 to 2004. Use of EVAR increased significantly from 6% of all emergency repairs in 2001 to 11% in 2004 (P < .01). Mortality for EVAR declined significantly from 43% to 29% (P < .01), but mortality with open repair showed no change (40% to 43%). From the 2003 to 2004 data set, 949 EVAR and 8982 open repairs were identified. Compared with open repair, the EVAR patients had lower mortality (31% vs 42%), shorter hospital stay (6 vs 9 days), and were more likely to be discharged to home (59% vs 37%, all P < .01). The total hospital charges for EVAR and open repair were similar ($71,428 vs $74,520, P = .59). Mortality for EVAR was significantly higher at nonteaching hospitals compared with teaching centers (55% vs 21%, P < ...
A Decade of Lessons Learned

- **Systems and Protocols Make a Difference**
- Algorithms serve as surrogates for an organized approach to rAAA’s and can be an overall marker for good quality care
  - Mortality
    - 18% in studies with an algorithm
      - (95%CI 10 to 26; \(I^2\) 86.9%)
    - 32% in those without
      - (95% CI 20 to 44; \(I^2\) 90.2%)

Moore et al. JVS 2007;45:443-50
Protocols for rAAA

- Pre-Hospital
- Emergency Room
- Operating Room
- ICU-Aftercare
Pre-Hospital

- Guidelines for Stabilization
  - Permissive Hypotension
- Regionalization of Care
- Imaging and Image Transfer
GUIDELINES FOR STABILIZATION & TRANSPORT OF PATIENTS WITH AORTIC DISSECTION OR AORTIC ANEURYSMS

The following clinical recommendations have been developed at the request of institutions that transfer patients with ruptured aortic aneurysms and/or aortic dissections. This protocol is in the interest of facilitating rapid, safe and expedient transfer while maximizing the chances for survival. As always please use your clinical judgment, these are only recommendations.

RUPTURED ABDOMINAL OR THORACIC AORTIC ANEURYSMS
ACUTE AORTIC DISSECTIONS | PENETRATING AORTIC ULCERATIONS

1. Call UW Medicine Transfer Center at 888-731-4791 to initiate transfer and begin upload of relevant CT images to PMCS. Transfer Center personnel will guide in this.
2. Establish (2) large bore peripheral IV's begin perioperative fluid administration.
3. Persuasive hypotension: Allow SBP >80mmHg for ruptures
4. For HTN iniciate:
   a. Remosyl get first:
      i. Load with 500 mcg/kg/min over 1 minute
      ii. Then 50 mcg/kg/min, minumum 1 cc/min
   b. Follow with Nipride get
      i. 0.3 to 0.5 mcg/kg/min over 1 minute
      ii. Increase by 0.5 mcg/kg/min to MAX 10 mcg/kg/min
   c. To keep MAP >80mmHg
5. Pain management—IV Morphine 2mg bolus IV p.r.n.
6. Patient warming with Heat Hugger
7. Oral SEP should be<80mmHg and <140mmHg
8. Oral HR <100
9. Oral O2 Set >90%

When possible—after speaking with the on-call vascular surgery attending you may be asked to do the following steps:
   * Insert A-line in right radial artery
   * Place Foley catheter to monitor urine output.
   * Clip hair in both groins, pubic area and entire abdomen.
   * Remove and package all clothing for transport
   * Insert 6Fr sheath in Right Common Femoral Artery—and swaddle in place with sterile dressing.
   (CAUTION: this test only be performed by IR, Cardiology or Surgeon trained in catheter-based techniques)

CALL UW MEDICINE TRANSFER CENTER AT: 888-731-4791
RUPTURED ABDOMINAL OR THORACIC AORTIC ANEURYSMS | ACUTE AORTIC DISSECTIONS | PENETRATING AORTIC ULCERATIONS

1. Call UW Medicine Transfer Center at 888-731-4791 to initiate transfer and begin upload of relevant CT images to PACS (Transfer Center personnel will guide in this).
2. Establish (2) large bore peripheral IVs, begin gentle IV fluid administration.
3. Permissive hypotension: Allow SBP >80mmHg for ruptures.
4. For HTN- initiate:
   a. Esmolol gtt first:
      i. Load with 500 mcg/kg/min over 1 minute
      ii. Then 50mcg/kg/min, titrate to effect
   b. Follow with Nipride gtt:
      i. 0.3 to 0.5mcg/kg/min over 1 minute
      ii. Increase by 0.5mcg/kg/min to MAX 10 mcg/kg/min.
   c. To keep MAP < 80mmHg
5. Pain management—IV Morphine 2 mg bolus IV p.r.n.
6. Patient warming with Bair Hugger.
7. Goal SBP should be >80mmHg and <140mmHg.
8. Goal HR <100.
9. Goal O2 Sat > 90%.
If time permits—after speaking with the on-call vascular surgery attending you may be asked to do the following steps:

- Insert A-line in right radial artery.
- Place Foley catheter to monitor urine output.
- Clip hair in both groins, pubic area and entire abdomen.
- Remove and package all clothing for transport.
- Insert 6Fr sheath in Right Common Femoral Artery—and sew in place with sterile dressing.

(*CAUTION: this must only be performed by IR, Cardiology, or Surgeon trained in catheter-based techniques*)

CALL UW MEDICINE TRANSFER CENTER AT: 888-731-4791

UWMEDICINE.ORG/TRANSFERCENTER
Pre-Hospital: Regionalization
Pre-Hospital Image Transfer

• Transfer Center
Emergency Room

• Pass-thru protocols
  – ID Band affixed to patients wrist on way to OR
  – Medics transfer patient directly onto OR table

• Massive Transfusion Protocol Activated

• Identify those patients with a 100% mortality risk
  – Implement Comfort Care Measures
Pre-operative predictors of death

- Admission pH < 7.1
- Age > 76
- Creat > 2.0
- Pre-op SBP < 70mmHg
Prediction of EVAR 30 day Survival

- 0 points: 72%
- 1 point: 91%
- 2 points: 63%
- 3 points: 30%
- 4 points: 0%

Bars represent:
- All Comers
- Open
- EVAR
Prediction of Open 30 day Survival

<table>
<thead>
<tr>
<th>Points</th>
<th>All Comers</th>
<th>Open</th>
<th>EVAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>70%</td>
<td>70%</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>20%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>18%</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
Harborview Risk Score for rAAA

- pH < 7.1
- Age > 76
- Creat > 2.0
- Pre-op SBP < 70mmHg

AUC 0.76

Compared with 0.64 for Robinson, Glasgow, and Edinburg Scores

* Based on Linear Discriminant Analysis
OR Protocols

YouTube “Rupture Setup Starnes”
OR Protocols

- Endovascular Inventory
- Local Anesthesia Preferred
- “The Strap Above the Knees”
- Aortic Occlusion Balloons
- Selection of Main Body Delivery
- DYNA Spin to Rule Out Type 1 Endoleak
OR Protocols
ICU Nursing Considerations

– The REVAR patients are *JUST AS SICK* as those undergoing open repair
– Aggressive resuscitation
– Low Index of Suspicion for:
  • Abdominal Compartment Syndrome
  • Ischemic Colitis
**Pre-Hospital Data:**

- Estimated Time of Rupture: ~10:00
- Vitals: SBP < 80 mmHg at any time? Y/N
- Temperature: 37.4°C
- CPR? Y/N
- Pressors? Y/N
- (amount/name)
- Intubated? Y/N
- Transfused? Y/N
- Necrotizing on arrival? Y/N
- Helicopter? Y/N
- Flight Time: 15 minutes
- CT Scan outside hospital? Y/N

**Hospital Data:**

- Emergency Dept: Time of arrival to HMC: 14:42
- Vitals on arrival: SBP 92, HR 101, Temp 37.5°C, Sat 99%
- Labs: HCT 0.13, Hb 13.3, B.E. +2.1, Hct 0.44, INR 1.3, PTT 14.4
- Operating Room:
  - Time of arrival to OR: 15:01
  - Vitals on arrival: SBP 124, HR 85, Temp 37°C
- Time of Access: 15:26
- Time of Main Body Deployment: 15:49
- Time of Gate Cannulation: 16:08
- Time End: 16:27

**Outcome Data:**

- Alive? Y/N
- Date of Death
- Date of Hospital Discharge
- LOS: ___ days
- Endoleak? Y/N
- Type 1, Type 2, Type 3, Resolved? Y/N
- Re-intervention? Y/N
- Date: ___
- Re-intervention Name
- Sac Size: Baseline ___ mm, 6mo ___ mm, 12 mo ___ mm, 24 mo ___ mm, 36 mo ___ mm
- Morbidity? (circle)
  - MI
  - Respiratory Failure
  - Renal Failure
  - Dialysis
  - Ischemic Colitis
  - Abdominal Compartment Syndrome
- Comments:
  - 29 x 96 - 1912078
  - 16 x 71 - 1917014
  - 16 x 71 - 1343082

**Aneurysm Details:**

- Aneurysm size: 5.5 cm
- Aneurysm size: 5.5 cm
- D1: 2.6 cm, D2: 1.4 cm, D3: 1.2 cm
- L1: 1.1 mm, L2: 5 mm, L3: 1.5 mm, L4: 2.5 mm
- Calcification > 40%? Y/N
- Thrombus > 40%? Y/N

**Operative Details:**

- Anesthetic: Local/IV
- Percutaneous? Y/N
- Sheath size: 20 Fr 16 Fr
- Abs? Y/N
- Heparin? Y/N
- Heparin Dose: 3,000 U
- Pre-deployment A-gram? Y/N
- Ao Balloon placed? Y/N
- Ao Balloon used? Y/N
- IVUS? Y/N
- Total Contrast used: 35 cc
- Fluoro Time: 13.0 min
- Procedure Time: 61 min
- EBL: 30 cc
- Fenestrated? Y/N
- Converted to AFX device? Y/N
- Converted to open? Y/N
- Decompressive Lap? Y/N
- Fem-Fem? Y/N
- Graft Sizes:
## 30-day Mortality

<table>
<thead>
<tr>
<th></th>
<th>Pre-protocol</th>
<th>Post-protocol</th>
<th>P-value¹</th>
<th>Open</th>
<th>EVAR</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total N</td>
<td>128</td>
<td>51</td>
<td></td>
<td>24</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td>N died in 30 days</td>
<td>74</td>
<td>18</td>
<td></td>
<td>13</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>30 day mortality rate</td>
<td><strong>57.8%</strong></td>
<td><strong>35.3%</strong></td>
<td><strong>0.008</strong></td>
<td>54.2%</td>
<td>18.5%</td>
<td>0.010</td>
</tr>
</tbody>
</table>

1. p-value from chi-sq test comparing pre and post protocol.
2. p-value from exact test comparing EVAR and Open among post-protocol.

**Relative Risk:** 35% reduction (95% CI: 14% to 51%)
**Absolute Risk difference:** 22.5% (95% CI: 6.8%-38.2%)
**Risk Ratio comparing pre and post:** 0.61 (95% CI: 0.41-0.91)
Mortality 2012

Overall REVAR protocol

2003 2004 2005 2006 2007 2008 2012

P<0.001

57.8% 25.3% 16.3%

Overall REVAR

0 10 20 30 40 50 60 70 80
From the Society for Vascular Surgery

Management of ruptured abdominal aortic aneurysm in the endovascular era

Benjamin W. Starnes, MD, Elina Quiroga, MD, Carolyn Hutter, MS, PhD, Nam T. Tran, MD, Thomas Hatsukami, MD, Mark Meissner, MD, Gale Tang, MD, and Ted Kohler, MD, Seattle, Wash
EVAR for Ruptured AAA

• Summary
  – Endovascular repair of ruptured abdominal aortic aneurysms saves lives.
  – Routine endovascular approach for ALL rAAA is feasible
  – Streamlined protocols improve outcomes for patients presenting with rAAA
  – With improvements in technology, more rAAA patients will be candidates for repair using an endovascular method.