“Modern Management of Vascular Catastrophes”

WAMI Trauma Conference
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“There is no disease more conducive to clinical humility than aneurysm of the aorta.”

William Osler c 1900
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

Endovascular Repair of Ruptured Aortic Aneurysms

- Published mortality rates after REVAR
  - 24 to 46%
  Moore et al. JVS 2007;45:443-50

REVAR

- Pooled mortality after REVAR- 21%
  (95% CI 13-29)
  - Unclear whether due to chance, selection bias or benefit of the technique
Algorithms

- Algorithms serve as surrogates for an organized approach to the problem and can be an overall marker for good quality care
  - Mortality
    - 18% in studies with an algorithm
      - (95% CI 10 to 26; I² 86.9%)
    - 32% in those without
      - (95% CI 20 to 44; I² 90.2%)

Nationwide Inpatient Sample

- Expanding use of emergency endovascular repair for ruptured abdominal aortic aneurysm: Disparities in outcomes from a nationwide perspective


2001-2004

- 28,123 admissions for rAAA
- EVAR increased from 6% to 11%
- Mortality declined from 43% to 29%
  - Mortality from open repair: No change (40% to 43%)
- EVAR patients:
  - Lower Mortality
  - Shorter Hospital Stay
  - More likely to be discharged home
Hospital Charges:
- $71,428 EVAR
- $74,520 Open

Mortality for REVAR
- Teaching hospital 21%
- Non-teaching hospital 55%

26 studies

Table I. Data from tables cited from 1994 to 2009 after outcomes of open repair for ruptured abdominal aortic aneurysms revised with current group grade grading system.

<table>
<thead>
<tr>
<th>Patient</th>
<th>Type</th>
<th>Procedure</th>
<th>Open</th>
<th>EVT-1</th>
<th>EVT-2</th>
<th>EVT-3</th>
<th>EVT-4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Site</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outcome</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table II. Data from New World population-based studies on outcomes of ruptured abdominal aortic aneurysm.

<table>
<thead>
<tr>
<th>Study</th>
<th>Study period</th>
<th>Location</th>
<th>Study Methods</th>
<th>Pre-hospital SBP &lt; 90 mmHg</th>
<th>Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Ambulance Ontario</td>
<td>1980-1989</td>
<td>186 patients</td>
<td>96% had pre-hospital SBP &lt; 90 mmHg</td>
<td>70% Mortality</td>
<td>3% in ER</td>
</tr>
</tbody>
</table>
Johansen et al., 1991

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

Ruptured Abdominal Aortic Aneurysm
The Harborview Experience - Part 2

Benjamin W. Starnes, MD, FACS

Elina Quiroga MD, Carolyn Hutter PhD, Nam T. Tran MD,
Thomas Hatsukami MD, Mark Meissner MD, Gale Tang MD,
Michael Sobel MD, Ted Kohler MD

Disclosure- Abbott Vascular- Consultant

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Objective

To evaluate the effect on mortality of the implementation of an algorithm to manage rAAA patients with a preference for EVAR when feasible.
Methods
Prospective, non-randomized intent-to-treat study with historical control comparison

"Pre-protocol" group
July 1, 2002 – June 30, 2007
ALL but one Open Historical Group

"Post-protocol" group
July 1, 2007 – April 30, 2009
Post-protocol Open Post-protocol EVAR

Primary Outcome Measure - 30-day Mortality

Results
187 patients presented with rAAA

Pre-protocol group
July 1, 2002 – June 30, 2007
131 Patients
128 Treated
24 Open
27 EVAR

Post-protocol group
July 1, 2007 – April 30, 2009
56 Patients
51 Treated

N=131
70% 65% 48% 59% 64%
Range 48-70%

Results: 2003-2007 Pre-protocol period
<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Total</th>
<th>Pre-protocol</th>
<th>Post-protocol</th>
<th>Post-EVAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>168</td>
<td>108</td>
<td>30</td>
<td>20</td>
</tr>
<tr>
<td>Male</td>
<td>100 (78.2%)</td>
<td>70 (62.1%)</td>
<td>25 (83.3%)</td>
<td>15 (75.0%)</td>
</tr>
<tr>
<td>SBP&lt;80</td>
<td>83 (64.9%)</td>
<td>45 (39.6%)</td>
<td>21 (68.3%)</td>
<td>17 (85.0%)</td>
</tr>
<tr>
<td>CPR</td>
<td>6 (4.7%)</td>
<td>3 (2.7%)</td>
<td>1 (3.3%)</td>
<td>2 (10.0%)</td>
</tr>
<tr>
<td>CT Scan*</td>
<td>76 (51.8%)</td>
<td>42 (38.5%)</td>
<td>18 (60.0%)</td>
<td>16 (80.0%)</td>
</tr>
<tr>
<td>Hct &lt;25</td>
<td>87 (64.9%)</td>
<td>47 (41.2%)</td>
<td>26 (86.7%)</td>
<td>14 (70.0%)</td>
</tr>
<tr>
<td>Transport time</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAD</td>
<td>66 (56.9%)</td>
<td>46 (38.5%)</td>
<td>10 (33.3%)</td>
<td>10 (50.0%)</td>
</tr>
<tr>
<td>HTN</td>
<td>73 (59.4%)</td>
<td>43 (36.7%)</td>
<td>23 (76.7%)</td>
<td>17 (85.0%)</td>
</tr>
<tr>
<td>COPD</td>
<td>29 (32.5%)</td>
<td>14 (12.2%)</td>
<td>8 (26.7%)</td>
<td>7 (35.0%)</td>
</tr>
<tr>
<td>Renal Insuf.*</td>
<td>7 (6.0%)</td>
<td>3 (2.7%)</td>
<td>2 (6.7%)</td>
<td>2 (10.0%)</td>
</tr>
<tr>
<td>Diabetes</td>
<td>9 (6.8%)</td>
<td>4 (3.4%)</td>
<td>2 (6.7%)</td>
<td>3 (15.0%)</td>
</tr>
</tbody>
</table>

30 day Mortality by Age

![Graph showing 30-day mortality by age before and after protocol changes.](image-url)
Survival of Patients Undergoing EVAR or Open in Pre and Post Protocol Eras

- **Pre-protocol**
  - Post-EVAR
  - Post-Open

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Analysis time

- 0
- 10
- 20
- 30

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Percentage Treated with EVAR by Year

- July 43–June 46
- July 47–April 48

- p=0.30

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30-day Mortality for both Open Surgery and EVAR by Year

- Open
- EVAR

- 52.9%
- 57.1%
- 26.7%
- 8.3%

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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-value²</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>57.8%</td>
<td>35.3%</td>
<td>0.008</td>
<td>54.2%</td>
<td>18.9%</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% to 38.2%)
Risk Ratio comparing pre and post: 0.61 (95% CI: 0.41 - 0.91)

• Overall Mortality

35% reduction in mortality versus historical controls

Absolute risk reduction 22.5%
- (95% CI: 6.8 - 38.2%)

Risk Ratio 0.61
- (95% CI: 0.41 - 0.91)

Factors associated with Mortality

- Advancing Age
- HCT <25%
- SBP <80mmHg at any time
EVAR for Ruptured AAA

Conclusions

- Endovascular repair of ruptured abdominal aortic aneurysms saves lives.
- Algorithms for managing ruptured abdominal aortic aneurysms with a preference for EVAR when feasible reduce mortality.
- Hospitals caring for patients with ruptured abdominal aortic aneurysms should have structured protocols in place and offer endovascular repair.
- In a single urban hospital utilizing modern techniques of resuscitation and surgical management, a majority of patients presenting with a rAAA can survive.
Considerations

- Pre-Hospital
  - Communication
  - Permissive Hypotension
  - Elective/Urgent Intubation
  - Warming
  - Imaging and Image Transfer

- Hospital
  - Time / Efficiency with EVAR
  - Facility-Rupture Room
  - Inventory
  - Anesthetic Considerations
  - Staffing
  - ICU care

Anesthetic Considerations

- Avoid General Anesthesia
- Avoid Elective Intubation
- Nitrous Oxide
- Dexmedetomidine
  - Central alpha agonist
  - No cardiac or resp supression

Important Technical Considerations

- Aortic Occlusion Balloon
- Gate Cannulation
  - One patient died- prolonged gate cannulation
  - Selection of Main Body delivery site
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
New Horizons- rAAA

- Hypothermia?
  - InnerCool
- Targeted Resuscitation?
  - Rapid Thromboelastography
- Anesthetic Technique?
  - Dexmedetomidine
- Simulation?

Hypothermia

<table>
<thead>
<tr>
<th>Time</th>
<th>Temp</th>
<th>Survivors</th>
<th>Non-survivors</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arrival to OR</td>
<td>15.3 (13.1-16.8)</td>
<td>15.8 (28.7-36.4)</td>
<td>0.004</td>
<td></td>
</tr>
<tr>
<td>Lowest</td>
<td>15.1 (13.2-17.4)</td>
<td>15.5 (27.9-36.2)</td>
<td>0.006</td>
<td></td>
</tr>
<tr>
<td>End of Procedure</td>
<td>15.8 (13.3-17.4)</td>
<td>15.4 (29.2-36.2)</td>
<td>0.001</td>
<td></td>
</tr>
</tbody>
</table>

Quiroga et al. (Data from 66 rAAA 2007-2009)
Hypothermia is Associated With Increased Mortality in Patients Undergoing Repair of Ruptured Abdominal Aortic Aneurysms

Olga Salazar, MD, New T. Tran, MD, Thomas Tenckhoff, MD, and Benjamin M. Starzl, MD
Division of Vascular Surgery, University of Washington, Seattle, Washington, USA.

Objective: To evaluate the impact of hypothermia on mortality in patients presenting with dissecting abdominal aortic aneurysm (AAA) and to determine if patients with ruptured AAA presented to our Emergency Department (ED) without a prior surgical repair were hypothermic upon arrival.

Methods: A retrospective analysis of prospectively collected data was performed on patients who presented to the ED with dissection or rupture of an AAA from January 1, 2002 to December 31, 2015. Hypothermia was defined as a core temperature <36°C. Impedance plethysmography was used to confirm AAA.

Results: A total of 17 patients were identified. Median age was 75 years (range: 36-91). The majority of patients (71%) presented with dissection. The median time to surgery was 2.5 hours (range: 0.5-10). Of these patients, 35% were hypothermic on arrival. Of those hypothermic patients, 74% died within 24 hours. Of the patients who were not hypothermic, none died within 24 hours.

Conclusion: Hypothermia is associated with increased mortality in patients presenting with dissecting or ruptured AAA. These findings may inform future clinical trials investigating mechanisms to prevent hypothermia in this population.
Custom Fenestrated Endografting for the Management of Complex Aortic Pathologies: Early Experience

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May, 2009
Clinical Extensions:

- 81 yo male - Alaskan Cruise
- Ruptured Thoracoabdominal Aneurysm
  - Survived transport 6 hours
  - BP low 100’s on Esmolol
  - O2 requirement - 6 liters - Sats 91%
EVAR for Ruptured AAA

- Summary
  - Routine endovascular approach for ALL rAAA is feasible
  - Variables affecting outcome for an endovascular approach are not well defined
  - Streamlined protocols improve outcomes for patients presenting with rAAA