Management of Small AAAs
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Small AAA Ultrasound Surveillance

<table>
<thead>
<tr>
<th>Aortic Diameter</th>
<th>Recommended Follow-up Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;2.5 cm</td>
<td>None</td>
</tr>
<tr>
<td>2.6 - 2.9</td>
<td>5 Years</td>
</tr>
<tr>
<td>3.0 - 3.4</td>
<td>3 Years</td>
</tr>
<tr>
<td>3.5 - 3.9</td>
<td>1 Year</td>
</tr>
<tr>
<td>4.0 - 4.9</td>
<td>6 Months</td>
</tr>
<tr>
<td>5.0 - 5.5</td>
<td>3 Months</td>
</tr>
</tbody>
</table>

Based on 30,000 65 yr old men screened in Gloucestershire, UK

Medical Management

- SMOKING CESSATION!!!
  - 50-200% increase in rupture risk w smoking
  - Smoking doubles the rate of expansion
- Control Blood Pressure!
  - Independent risk factor for rupture
- Atherosclerotic Risk Factors
  - Leading cause of death...
- And...

Medical Management: Medications

- **Doxycycline** has been shown to decrease aneurysm expansion in animals, and has modest success in small rand. human trials
  - Issues are side effects and length of tx
- Statins have been associated with a reduction in aneurysm expansion in 3 human studies
  - Roughly one-half the rate of expansion
  - Many aneurysm patients have independent indications for statins already
  - Lowers surgical mortality if aneurysm repair needed
  - 20% of patients will have side effects that limit use
**When Should AAAs Be Repaired?**

When the rupture risk is high compared with the operative risk, in patients with sufficient life expectancy to enjoy the benefit of a prophylactic operation.

**AAA Rupture Risk - Size**

- **Olmstead County, MN, Population-based**
  - < 4 cm: 0% / year
  - 4-4.9 cm: 1% / year
  - 5-5.9 cm: 11% / year
  - 6-6.9 cm: 26% / year

- **UK Small Aneurysm Trial**
  - < 4 cm: 0.3% / year
  - 4-4.9 cm: 1.5% / year
  - 5.0-5.9 cm: 6.5% / year

- Dramatic increase between 5-6 cm diameter

**Randomized Trials**

**Early Surgery vs. Surveillance of 4.0-5.4 cm AAAs**

- **UK SAT Trial** – 1090 patients, age 60-76
  - Elective (open) operative mortality: 5.8%
  - Surveillance: 61% elective repair, 1%/yr rupture
  - Survival: 64% in both groups at 6 years

- **VA ADAM Study** – 1136 (male) patients, age 50-79
  - Elective (open) operative mortality: 2.7%
  - Surveillance: 61% elective repair, 0.6%/yr rupture
  - Survival: 78% surgery, 81% surveillance at 5 years

- Careful surveillance with repair at 5.5 cm is reasonable
Survival: UK Small Aneurysm Trial

Applying AAA Trial Results to Practice

- UK Trial: Patients <70 with >4.5 cm AAAs showed trend toward benefit of early surgery.
- VA Study: 1% women (at higher rupture risk).
- High compliance with surveillance may not be achieved in practice (~70%, Valentine, 2000)
- Patient preference - risk aversion important when alternative treatments are comparable
- AAA diameter is not the only factor that determines rupture risk.

AAA Rupture: Not Just Size

- Proven independent risk factors for rupture:
  - Female gender 3.0 X
  - AAA diameter 2.9 X per cm
  - COPD 0.62/(L FEV)₁
  - Current smoking 1.5 X
  - Hypertension 1.02 per mm Hg
- Probable risk factors
  - Family history
  - Rapid expansion

- UK Small Aneurysm Trial
AAA Wall Stress Superior to Diameter For Estimating Aneurysm Rupture Risk

Results – 3D Stress Analysis

AAA Wall Stress - Finite Element Analysis

AAA Wall Stress: Finite Element Analysis

Maximum Diameter 5.5 cm

Maximum Diameter 5.5 cm
Comparison with Other Indices – Diameter Matched Controls

<table>
<thead>
<tr>
<th>Index</th>
<th>Elective(n = 20)</th>
<th>Ruptured or Symptomatic(n=16)</th>
<th>Difference</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max AAA diameter, cm</td>
<td>6.6 ± .2</td>
<td>6.6 ± .2</td>
<td>0%</td>
<td>.9</td>
</tr>
<tr>
<td>Peak Wall Stress, N/cm²</td>
<td>38.1 ± 1.3</td>
<td>46.8 ± 4.5</td>
<td>23%</td>
<td>.05</td>
</tr>
<tr>
<td>LaPlace (Max Dia x SBP), N cm²</td>
<td>18.8 ± .6</td>
<td>20.7 ± 1.4</td>
<td>10%</td>
<td>.2</td>
</tr>
<tr>
<td>Max AAA dia/infrarenal ao dia</td>
<td>2.9 ± .1</td>
<td>2.8 ± .2</td>
<td>-3%</td>
<td>.8</td>
</tr>
<tr>
<td>Max AAA dia/suprarenal ao dia</td>
<td>2.8 ± .1</td>
<td>2.8 ± .1</td>
<td>0%</td>
<td>.8</td>
</tr>
<tr>
<td>Max AAA dia/transverse dia L3</td>
<td>1.5 ± .05</td>
<td>1.57 ± .05</td>
<td>5%</td>
<td>.4</td>
</tr>
<tr>
<td>Max AAA dia/AAA length</td>
<td>.7 ± .04</td>
<td>.6 ± .05</td>
<td>-14%</td>
<td>.1</td>
</tr>
</tbody>
</table>

- Fillinger et al, J Vasc Surg, 2002

Accuracy in Predicting Rupture

Rate of Rupture: Diameter and Stress

Rupture Risk Assessment

- Proportional hazards analysis:
  - Diameter, max peak wall stress, age, gender, blood pressure
- Only significant variables:
  - Stress $>44$ N/cm²:
    - Relative risk 23x, $p<0.0001$
  - Female Gender:
    - Relative risk 3x, $p<0.005$

Rupture at Location of Peak Wall Stress

Estimating AAA Rupture Risk

<table>
<thead>
<tr>
<th></th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter</td>
<td>&lt; 5 cm</td>
<td>5-6 cm</td>
<td>&gt; 6 cm</td>
</tr>
<tr>
<td>Gender</td>
<td>Male</td>
<td>Female</td>
<td></td>
</tr>
<tr>
<td>Wall Stress</td>
<td>Low 35 N/cm²</td>
<td>Mdm 45 N/cm²</td>
<td>High 55 N/cm²</td>
</tr>
<tr>
<td>Smoking/COPD</td>
<td>None, mild</td>
<td>Moderate</td>
<td>Severe/steroids</td>
</tr>
<tr>
<td>Expansion Rate</td>
<td>&lt; .3 cm/yr</td>
<td>.3-.6 cm/yr</td>
<td>&gt; .6 cm/yr</td>
</tr>
<tr>
<td>Family History</td>
<td>None</td>
<td>One</td>
<td>Multiple</td>
</tr>
<tr>
<td>Hypertension</td>
<td>None</td>
<td>Controlled</td>
<td>Uncontrolled</td>
</tr>
</tbody>
</table>

When Should AAAs Be Repaired?

Patient Selection

Rupture Risk | Operative Risk | Life Expectancy

30 Day Mortality of Elective Open AAA Repair
US Medicare Patients -1996

30-Day Mortality (%)

- Dartmouth Atlas of Vascular Health Care
Open AAA Operative Mortality

- Independent predictors
  - Creatinine > 1.8 6x
  - Cardiac ischemia 3x
  - COPD 2.5x
  - Age (per decade) 2.1x

- Surgeon / hospital specific results
  - Importance of volume and specialty training

Mortality of Elective Open AAA Repair

Effect of Surgeon Volume – Medicare Patients

- UK Small Aneurysm Study Brady et al, Br J Surg, 2000

Predicting Open AAA Operative Mortality

- Surgeon-specific average mortality:
  - 3% 4% 5% 6% 8% 12%
  - Score -5 -2 0 +2 +5 +10

- Individual risk factors:
  - Age 60 70 80 Creat >1.8 +12
  - Score -4 0 +4 COPD +7
  - CHF +8; EKG Ischemia +8; MI +3; Female: +4

- Estimated individual mortality:
  - Total Score: -5 0 5 10 15 20 24 30 35 40
  - Op Mortality(%): 1 2 3 5 8 12 19 28 39 51

Endovascular AAA Repair

- Reduced mortality, morbidity, recovery time, LOS
- Higher re-intervention rate, some late ruptures
**EVAR 1 Trial**

  - Comparison of endovascular aneurysm repair with open repair in patients with abdominal aortic aneurysm (EVAR trial 1)
  - Randomized controlled clinical trial
  - >1000 patients
  - Significantly lower 30-day mortality for EVAR vs Open AAA repair (EVAR 1.6% vs Open 4.6%, p=.0007).
  - In follow-up, secondary interventions were more common in patients allocated EVAR (9.8% vs 5.8%, p=0.02)
  - Aneurysm-related mortality benefit persists to 4 yrs

**U.S. Medicare: EVAR vs Open 2001-2004**

<table>
<thead>
<tr>
<th></th>
<th>EVAR</th>
<th>Open</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mortality (30 day)</td>
<td>1.2%</td>
<td>4.8%</td>
<td>.001</td>
</tr>
<tr>
<td>Discharge to rehab facility</td>
<td>5.6%</td>
<td>18.4%</td>
<td>.001</td>
</tr>
<tr>
<td>Late rupture (4 years)</td>
<td>1.8%</td>
<td>0.5%</td>
<td>.001</td>
</tr>
<tr>
<td>Secondary aneurysm procedures</td>
<td>9.0%</td>
<td>1.7%</td>
<td>.001</td>
</tr>
<tr>
<td>Surgery for bowel obstruction</td>
<td>4.1%</td>
<td>9.7%</td>
<td>.001</td>
</tr>
<tr>
<td>Hospitalization for bowel obstruction</td>
<td>8.1%</td>
<td>14.2%</td>
<td>.001</td>
</tr>
<tr>
<td>Total 2 procedure/hosp</td>
<td>21.2%</td>
<td>25.6%</td>
<td></td>
</tr>
</tbody>
</table>


**Endovascular vs Open AAA Repair**

- Decision analysis using Eurostar and Medicare data
- Comparable quality-adjusted survival
  - Higher initial morbidity, mortality open repair
  - Offset by late intervention, rupture of EVAR
- Endovascular Repair Does not change the threshold diameter for repair in most patients

**Benefit of EVAR Relative to Pt Health**

**Patient fitness and survival after abdominal aortic aneurysm repair in patients from the UK EVAR trials**

**The EVAR Trial Participants**


Correspondence to: M.J. C. Berry, Vascular Surgery Research Group, Imperial College London, Department of Vascular Surgery, Charing Cross Hospital, Fulham Palace Road, London W6 8RF, UK (e-mail: mcberry@imperial.ac.uk)

**Background:** The aim was to use a validated fitness score to determine whether fitter patients with a large abdominal aortic aneurysm (AAA) benefited from having open rather than endovascular repair.

**Methods:** The Cerebral Performance Category Index (CPC) was applied to patients in the Endovascular Aneurysm Repair (EVAR) I and II trials. Interaction terms between CPC and randomized group assessed the effect of fitness and type of AAA repair on outcomes: 30-day mortality and 5-year survival.

**Results:** The median CPC scores were 3 (95% CI: 2.2-3.5) for 522 EVAR I patients and 0 (95% CI: 0-1) for 404 EVAR II patients (range: 0-3). This shows that EVAR patients were classified as good (79% patients, mean CPC = 2.2, moderate = 14% patients, mean CPC = 2.8), and poor (14% patients, mean CPC = 4.2). Only in the good-fitness group did 30-day mortality consistently favour endovascular repair (odds ratio 0.64, P = 0.02), but overall the type of intervention was not significant (P = 0.65). For 4-year all-cause and aneurysm-related mortality, there was no benefit for either treatment across all fitness scores (P = 0.24 and P = 0.72 respectively).

**Conclusion:** The benefit of endovascular repair was mostconsistent in the fitter patients. There was no evidence that the fitter patients benefited more from surgery.
Predicting EVAR Operative Mortality

<table>
<thead>
<tr>
<th>Scoring System</th>
<th>Mortality</th>
<th>Morbidity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AUC</td>
<td>95% CI</td>
</tr>
<tr>
<td>GAS</td>
<td>0.678</td>
<td>0.48-0.87</td>
</tr>
<tr>
<td>V-POSSUM</td>
<td>0.663</td>
<td>0.51-0.81</td>
</tr>
<tr>
<td>m-CPI</td>
<td>0.629</td>
<td>0.45-0.81</td>
</tr>
<tr>
<td>CPI</td>
<td>0.646</td>
<td>0.49-0.81</td>
</tr>
</tbody>
</table>

When Should AAAs Be Repaired?

- Surveillance of AAAs < 5.5 cm is safe, but:
  - Compliance with follow-up must be high
  - Repair for rapid expansion
  - Some AAAs < 5.5 cm are higher risk:
    - Female, smoker, COPD, high wall stress
- Threshold diameter higher if high operative risk
- Indications are same for open and endo repair
- Ultimately decisions must be individualized based on these factors and patient preferences

Thank You!