ORIGINAL CONTRIBUTION

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Outcomes Following Endovascular vs Open Repair of Abdominal Aortic Aneurysm

A Randomized Trial

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Context Limited data are available to assess whether endovascular repair of abdominal aortic aneurysm (AAA) improves short-term outcomes compared with traditional open repair.

Objective To compare postoperative outcomes up to 2 years after endovascular or open repair of AAA in a planned interim report of a 9-year trial.

Design, Setting, and Patients A randomized, multicenter clinical trial of 881 veterans (aged ≥49 years) from 42 Veterans Affairs Medical Centers with eligible AAA who were candidates for both elective endovascular repair and open repair of AAA. The trial is ongoing and this report describes the period between October 15, 2002, and October 15, 2008.

Intervention Elective endovascular (n=444) or open (n=437) repair of AAA.

Main Outcome Measures Procedure failure, secondary therapeutic procedures, length of stay, quality of life, erectile dysfunction, major morbidity, and mortality.

Results Mean follow-up was 1.8 years. Perioperative mortality (30 days or inpatient) was lower for endovascular repair (0.5% vs 3.0%; $P=.004$), but there was no significant difference in mortality at 2 years (7.0% vs 9.8%, $P=.13$). Patients in the endovascular repair group had reduced median procedure time (2.9 vs 3.7 hours), blood

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AAA Repair

One of the 5 surgical procedures that cause the most in-hospital deaths (ACS NSQIP, NEJM 10/1/09)

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OVER Trial Design

- Multicenter randomized clinical trial
- Open repair vs. any FDA-approved EVR system
- AAA ≥ 5.0 cm, candidate for both procedures
- 1º outcome (for full study) = mortality

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Time Line

- Study began Oct 2002, re-configured 2005
- 9-year study, ends Oct 2011
- Enrollment ended Apr 2008, n = 881 (42 centers)
  $\rightarrow$ 80% power to detect 25% difference in mortality
- 1 planned short-term report, cutoff Oct 2008
  - To ensure that short term post-operative outcome data would be disseminated while still maximally relevant
  - Original plan was 1-yr data only, changed to 2 yr (without knowledge of results) because of important changes in second year of EVAR-1 and DREAM
- Vital status Oct 2008 on all but 2 pts (death index neg)

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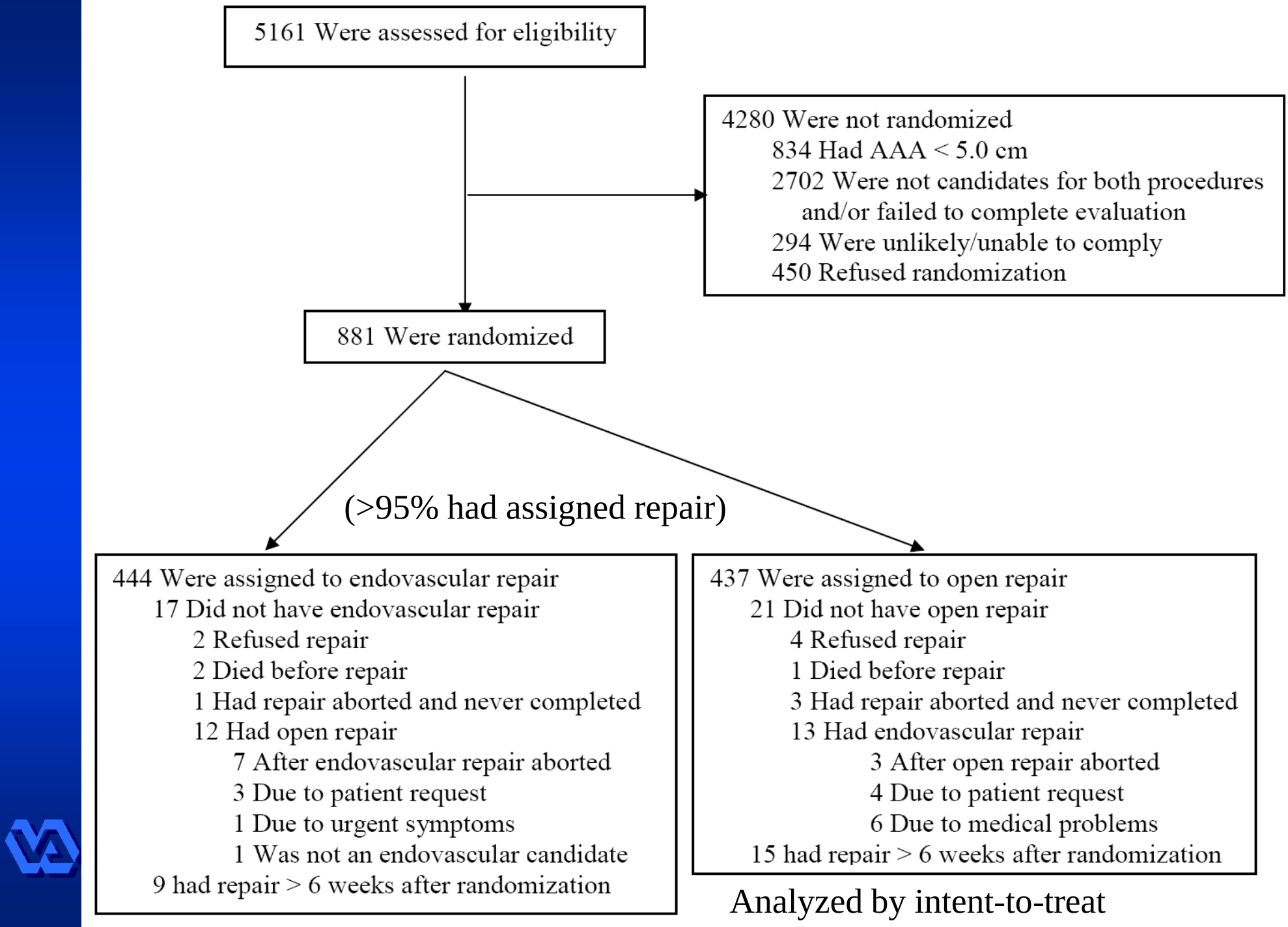
5161 Were assessed for eligibility
4280 Were not randomized
834 Had AAA < 5.0 cm
2702 Were not candidates for both procedures and/or failed to complete evaluation
294 Were unlikely/unable to comply
450 Refused randomization
881 Were randomized
(>95% had assigned repair)
444 Were assigned to endovascular repair
17 Did not have endovascular repair
2 Refused repair
2 Died before repair
1 Had repair aborted and never completed
12 Had open repair
7 After endovascular repair aborted
3 Due to patient request
1 Due to urgent symptoms
1 Was not an endovascular candidate
9 had repair > 6 weeks after randomization
437 Were assigned to open repair
21 Did not have open repair
4 Refused repair
1 Died before repair
3 Had repair aborted and never completed
13 Had endovascular repair
3 After open repair aborted
4 Due to patient request
6 Due to medical problems
15 had repair > 6 weeks after randomization
Analyzed by intent-to-treat

OVER Patient Characteristics

- 99.3% male 87% white
- Mean age: 70 years Mean wt: 90 kg
- Current smoker: 41%
- Coronary artery disease: 41%
- AAA diameter < 5.5 cm: 43%
  ≥ 6.0 cm: 27%

- EVR system:
  Cook Zenith: 39%, Gore Excluder: 37%
  Medtronic Aneurx: 21%, Guidant/Endologix: 3%

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EVR reduced: duration of procedure & mechanical ventilation, amt of blood loss & transfusions, and hospital & ICU stay, but added substantial exposure to radiation and contrast

Table 2. Details of Aneurysm Repair by Randomly Assigned Group[a]

	Median (Interquartile Range)	
	Endovascular Repair (n = 439)	Open Repair (n = 429)
Patients with aorta as distal attachment site (vs iliac/femoral), No. (%)	23 (5.2)	190 (44.3)
Time from randomization to repair, d	18.0 (10.0-28.0)	17.0 (9.0-26.0)
Duration of procedure, h	2.9 (2.3-3.7)	3.7 (2.9-4.7)
Duration of mechanical ventilation, h	3.6 (3.0-4.5)	5.0 (4.0-9.1)
Duration of fluoroscopy, min	23.0 (17.0-31.0)	0
Volume of contrast used, mL	132.5 (96.5-176.0)	0
Estimated blood loss, mL	200 (150-400)	1000 (650-2000)
Banked red cell transfusion within 24 h, unit	0	1.0 (0-3.0)
Duration of hospital stay for initial repair, d	3.0 (2.0-5.0)	7.0 (6.0-10.0)
Time in intensive care unit, d	1.0 (1.0-2.0)	4.0 (3.0-6.0)

[a] Patients who had no repair (refused, aborted and never completed, or died before repair in Figure 1) are not included. $P < .001$ for all comparisons, except time from randomization to repair ($P = .36$).

Mortality

Outcomes	No. (%) of Patients		*P* Value
	Endovascular Repair (n = 444)	Open Repair (n = 437)	
All-cause mortality	31 (7.0)	43 (9.8)	.13
Before AAA repair	2 (0.5)	1 (0.2)	>.99
Within 30 d after repair	1 (0.2)	10 (2.3)	.006
Within 30 d after repair or during hospitalization	2 (0.5)	13 (3.0)	.004
AAA diameter <5.5 cm	1 (0.5)	5 (2.6)	.10
AAA diameter ≥5.5 cm	1 (0.4)	8 (3.2)	.02
After 30 d or hospitalization	27 (6.1)	29 (6.6)	.74

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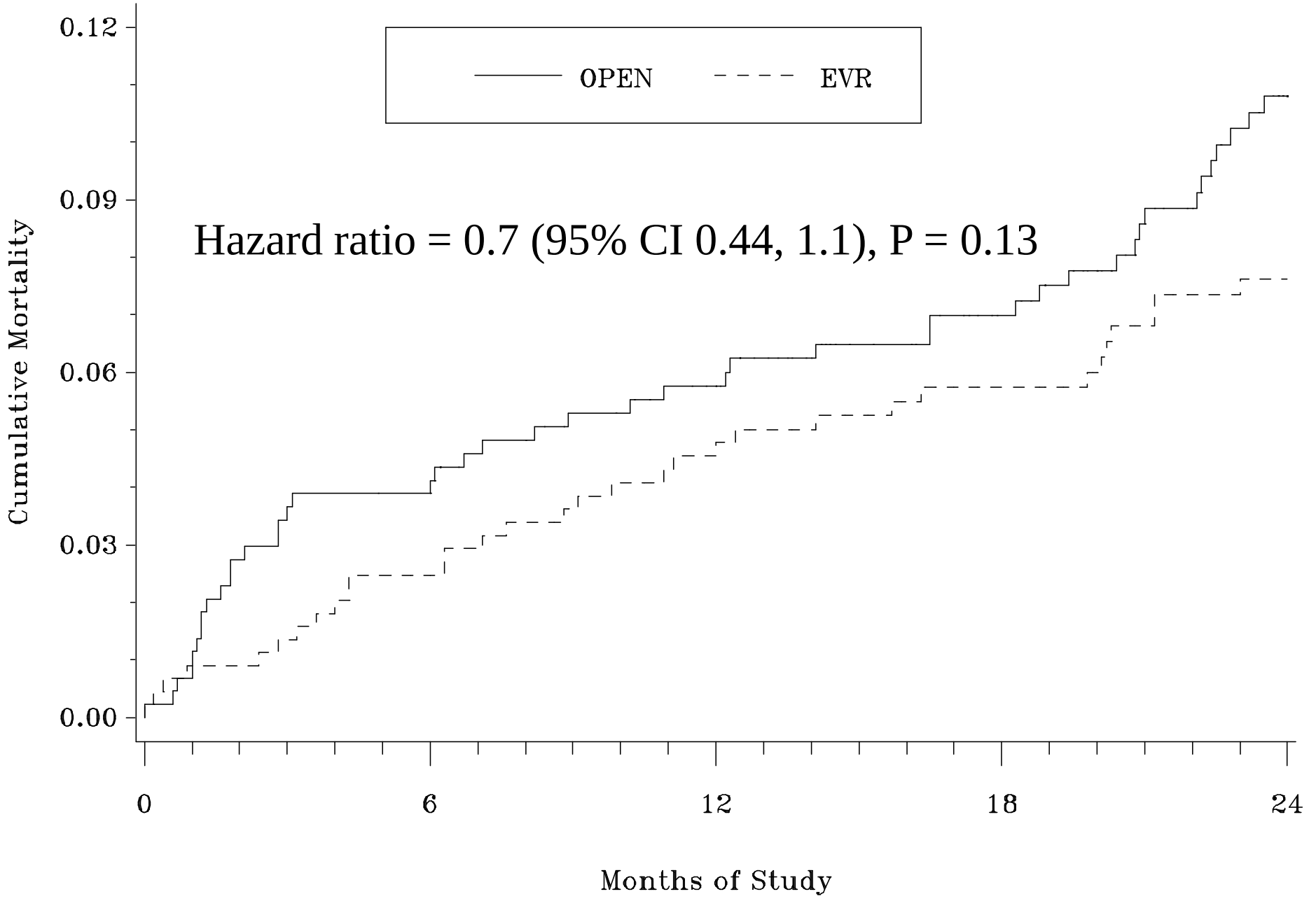

Number at risk

OPEN:	437	420	396	363	310
EVR:	444	433	411	371	326

Cause of death	EVR *n = 444*	Open *n = 437*
	no. (%)	
AAA-related (includes 30 days + hospitalization)*	6 (1.4)	14 (3.2)
Cardiovascular	9 (2.0)	3 (0.7)
Cancer	10 (2.3)	15 (3.4)
Other	5 (1.1)	7 (1.6)
Unknown	1 (0.2)	4 (0.9)

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*Late AAA-related deaths EVR: 4 Open: 1

Secondary Outcomes

	EVR *n = 444*	Open *n = 437*
	no. (%)	
Patients with procedure failure	58 (13.1)	51 (11.7)
Patients with no repair attempted	4	5
Patients with aborted initial procedure	8	6
Patients having secondary therapeutic procedures	46 (10.4)	40 (9.2)
All secondary therapeutic procedures	61	55
Patients with any one-year major morbidity	18 (4.1)	20 (4.6)
Myocardial infarction	6	12
Stroke	7	4
Amputation	1	3
Renal failure requiring dialysis	5	3
Patients with new or worsened claudication	37 (8.3)	20 (4.6)
All post-repair aneurysm-related hospitalizations	108	86

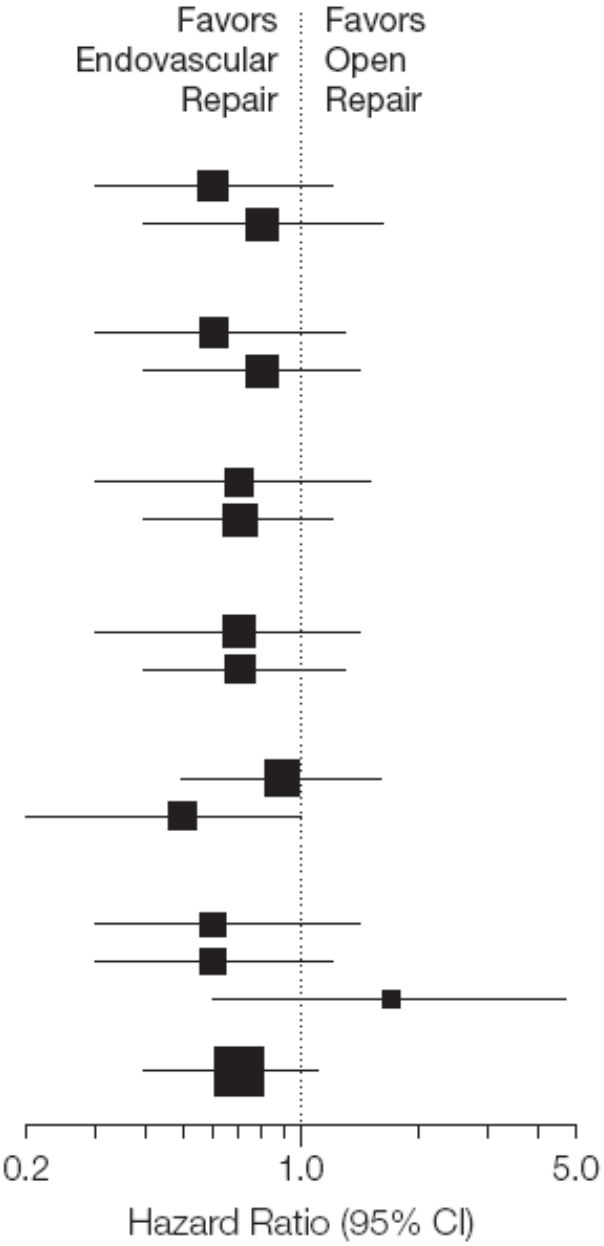
Secondary therapeutic procedures

Endovascular repair group		**Open repair group**	
42	endovascular procedures	24	incisional hernia repairs
3	explant graft and conversion to open repair	7	aortic graft procedures
9	other arterial procedures w open component	4	procedures for wound complications
5	groin wound procedures	4	amputations**
2	amputations*	4	laparotomy for bowel obstruction
		2	laparotomy for hematoma
		2	procedures to relieve claudication
		8	miscellaneous minor procedures
61	total	55	total

*both legs of one patient ** one toe, one leg, and below and above knee on same leg

Figure 3. Hazard Ratios for Death According to Baseline Characteristics

Subgroup	No. Patients	No. Deaths	Hazard Ratio (95% CI)
Randomization period			
Before April 15, 2005	413	40	0.6 (0.3-1.2)
After April 15, 2005	468	34	0.8 (0.4-1.6)
Age, y			
<70	406	26	0.6 (0.3-1.3)
≥70	475	48	0.8 (0.4-1.4)
AAA diameter, cm			
<5.5	382	27	0.7 (0.3-1.5)
≥5.5	499	47	0.7 (0.4-1.2)
Surgical risk (RAND score)			
Low	467	29	0.7 (0.3-1.4)
Intermediate or high	405	42	0.7 (0.4-1.3)
Coronary artery disease			
No	522	43	0.9 (0.5-1.6)
Yes	359	31	0.5 (0.2-1.0)
Intended endovascular system			
Cook Zenith	341	26	0.6 (0.3-1.4)
Gore Excluder	327	28	0.6 (0.3-1.2)
Medtronic AneuRx	186	15	1.7 (0.6-4.7)
Overall	881	74	0.7 (0.4-1.1)



More on outcomes

- No ruptures identified at 2 years
- Late AAA-related deaths: 4 in EVR vs. 1 in open
  - 2 of 4 EVR w AneuRx, as were both peri-op EVR deaths
- EVR group: 134 endoleaks in 110 pts (25%)
  → 21 secondary therapeutic procedures in 18 pts
  - 15 of these in 13 patients were Type II (& 1 Type III)
- Open group: 30 incisional hernias (7.1%)
  → 24 secondary therapeutic procedures in 21 pts

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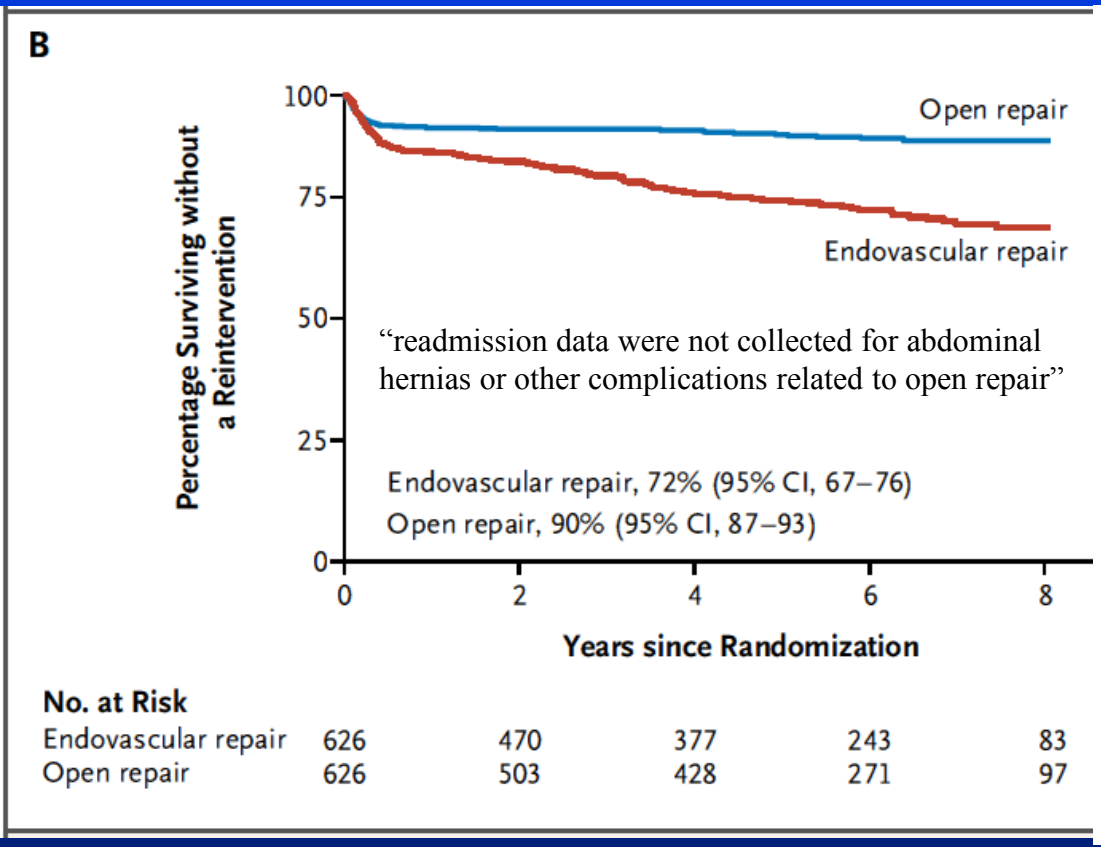
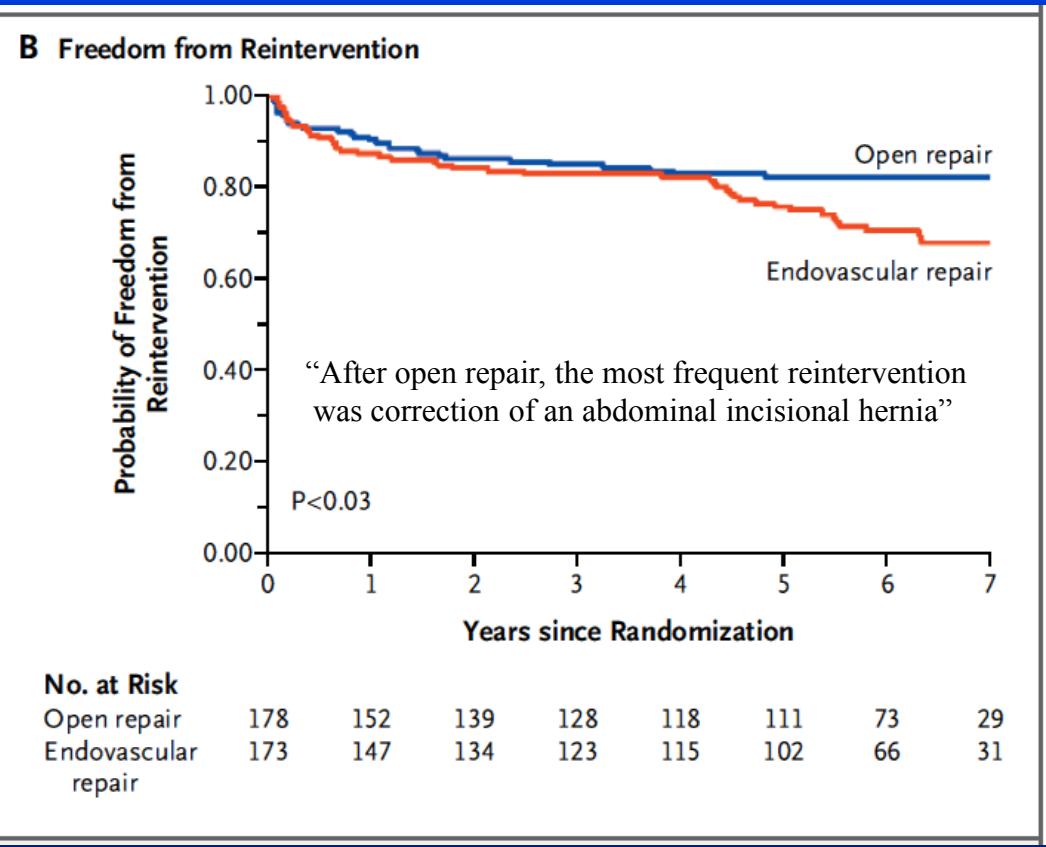
Long-term Reintervention

EVAR-1



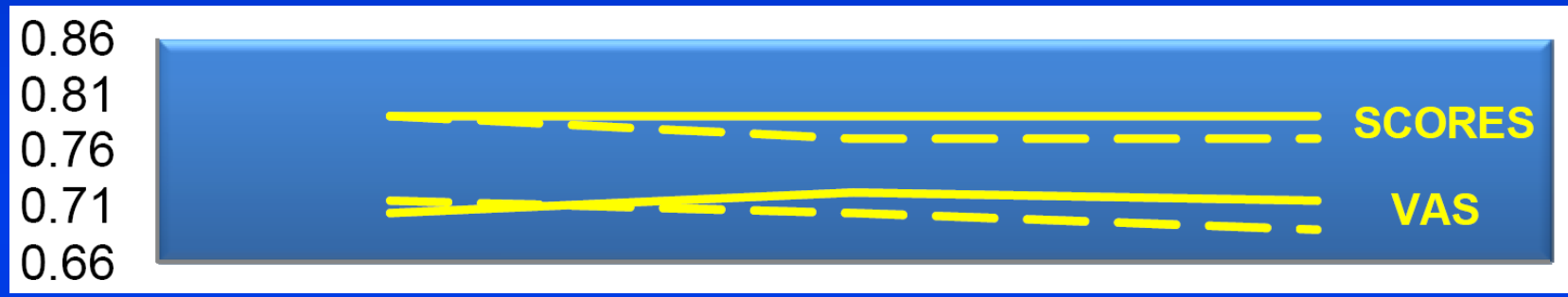
DREAM



Better health

SF-36

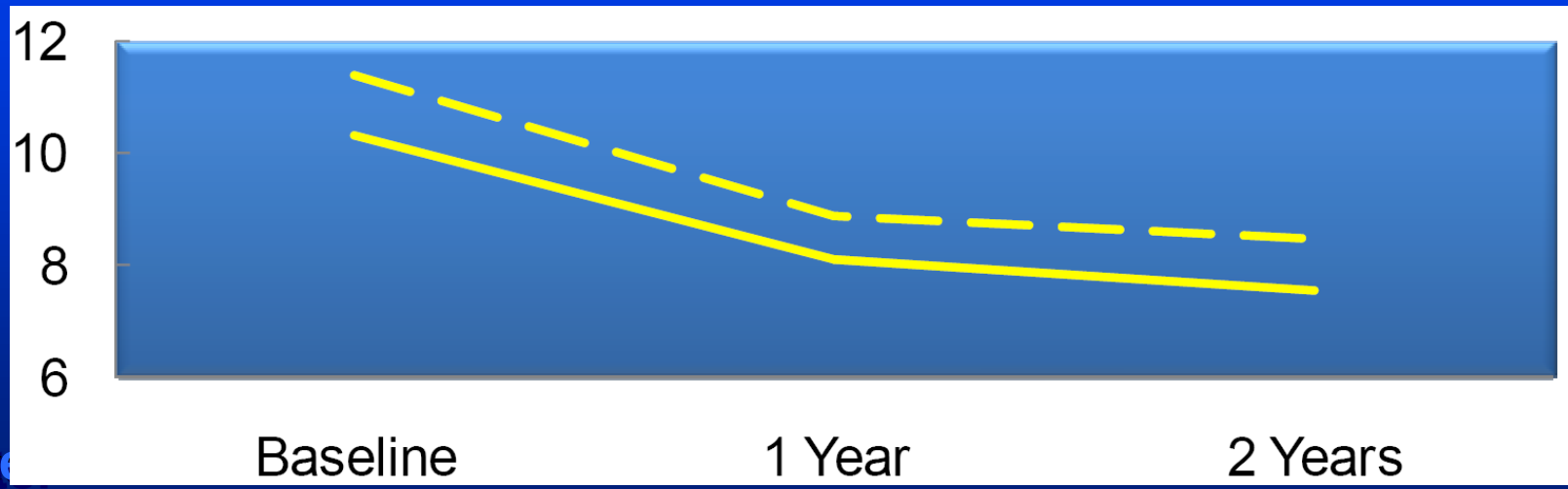
EQ-5D



EVR

OPEN

IIEF-5



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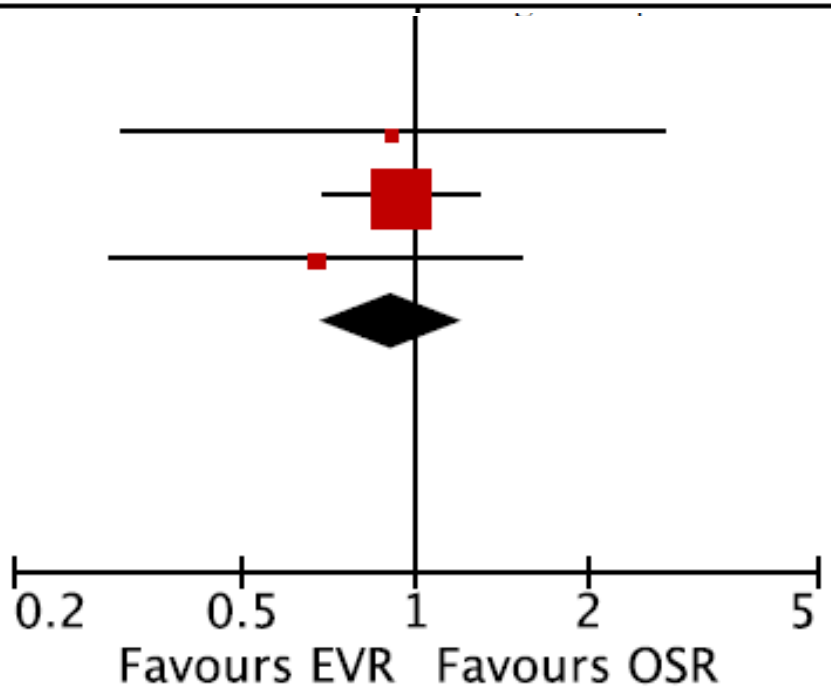
Worse Health

Study or Subgroup	Weight	Hazard Ratio IV, Fixed, 95% CI
1.1.4 24-month		
DREAM	6.8%	0.91 [0.31, 2.71]
EVAR 1	81.2%	0.94 [0.69, 1.30]
OVER	11.9%	0.67 [0.29, 1.53]
Subtotal (95% CI)	**100.0%**	**0.91 [0.68, 1.20]**

Heterogeneity: $Chi^2 = 0.57$, $df = 2$ ($P = 0.75$); $I^2 = 0\%$

Test for overall effect: $Z = 0.69$ ($P = 0.49$)



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Discussion

Mortality within 30 days or inpatient

	EVR	Open
EVAR-1	2.1%	6.2%
DREAM	1.2%	4.6%
OVER	0.5%	3.0%

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Possible reasons for lower operative mortality in OVER compared with EVAR-1 & DREAM

1) Difference in timing
   - OVER was intentionally started later to study a more mature technology
   - EVAR-1 & DREAM procedures: 1999-2003
   - OVER procedures: 2002-2007
   - (These improvements over time are another good argument for surveillance to 5.5 cm per UKSAT & ADAM)

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2) Differences in national inpatient mortality rates after non-ruptured AAA repair

- England 1996-2004 (Aylin 2007)
  - 31,705 repairs. Mortality: 10.2%
- UK 2000-5 (Holt 2007)
  - 20,360 repairs. Mortality: 11.2%

- US 2001-4 (McPhee 2007)
  - 146,684 repairs. Mortality: 4.5% open, 1.0% EVR
- Mortality after AAA repair in VA is lower than other US providers (Hutter, J Am Coll Surg 2007;204:1115)

Summary & Conclusions

- Peri-op mortality was lower for EVR than open, and lower for both procedures than in earlier trials.
- EVR reduced: duration of procedure & mechanical ventilation, amt of blood loss & transfusions, and hospital & ICU stay
- EVR → substantial exposure to radiation and contrast
- No differences in: major morbidity, procedure failure, secondary procedures, AAA-related hospitalizations, QOL, erectile function, or total mortality
- Long term data are needed to properly compare the two procedures (OVER final results in 2012).

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