Outcome of Early Surgery Compared to Surveillance in the Management of Small Aortic Aneurysms—A Comparative Mortality Analysis

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When underwriting individuals with aortic aneurysms, the following factors are used in risk selection: location, initial size, stability or velocity of change in size and co-morbid impairments. Treatment options based on clinical and ultrasonic findings are either surveillance or surgical resection. A recent study examined the 8-year outcome of early-surgery vs surveillance in small (4.6 cm) aortic aneurysms. Over the duration, the early-surgery group had a mortality ratio of 170% and excess death rate of 28; the surveillance group had a mortality ratio of 215% and excess death rate of 45. First-year mortality was expectedly high in the early-surgery group. Excluding first-year experience, the early-surgery group had an improved mortality ratio of 160% and excess death rate of 22. After 6 months, the death rate in the early-surgery group was about three fourths that of the surveillance group. However, due to high initial mortality, cumulative survival curves did not cross in favor of early-surgery until about 3 years.

Controversy continues on the timing and outcome of elective surgical repair of aortic aneurysms. Various criteria have been proposed using initial size and velocity of diameter increase to assist in the surgical triage. A publication on elective repair vs ultrasonic surveillance of aortic aneurysms is the subject of this mortality abstract.1 Comparative mortality outcomes of the 2 groups with aortic aneurysms between 4.0 cm and 5.5 cm over a mean follow-up of 8 years are reviewed.

STUDY GROUPS

Between September 1991 and October 1995, 1276 patients ages 60 to 76 from hospitals in the United Kingdom were identified as having asymptomatic, infrarenal aortic aneurysms 4.0 cm to 5.5 cm in diameter. Of the original group, 1090 (902 male and 188 female) gave written consent and were enrolled in the study. By random assignment, 563 (52%) were assigned to undergo elective surgery and 527 (48%) to continue ultrasonic surveillance. Table 1 shows sex distribution, mean age and mean initial aneurysm diameter of each group. The trial was closed June 30, 1998. However, since only 28% of the enrollees had died, the authors decided to undertake a further analysis when 100 surviving patients would have completed 8 years of follow-up and approximately half of the original cohort would have died. Final follow-up ended August 30, 2001. Mean duration of ob-

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Table 1. Sex Distribution, Mean Age and Mean Initial Aneurysm Diameter for Each Study Group

<table>
<thead>
<tr>
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<th>Ultrasonic Surveillance</th>
<th>Early Elective Surgery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>434 male, 93 female</td>
<td>468 male, 95 female</td>
</tr>
<tr>
<td>Aneurysm size</td>
<td>4.61 ± 0.37 cm</td>
<td>4.63 ± 0.40 cm</td>
</tr>
<tr>
<td>Mean age</td>
<td>69.2 ± 4.4</td>
<td>69.3 ± 4.4</td>
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The surveillance group was offered surgery for the following clinical conditions:

- Aneurysm diameter exceeded 5.5 cm
- Aneurysm expanded by more than 1 cm per year
- Aneurysm was tender or symptomatic
- Repair of a proximal or iliac aneurysm was scheduled

At the end of follow-up, 93.4% of the elective, early-surgery and 73.8% of the surveillance group had undergone aortic aneurysm resection. Of the surveillance group, only 6.3% survived without surgery at the end of observation. A total of 31 patients, 8% surveillance and 4% early-surgery, died from a ruptured aneurysm. Ten (32.2%) of the deaths were participants who refused surgery or were no longer surgical candidates. In a minority of these deaths, the aneurysm exceeded 5.5 cm.

AUTHOR’S MORTALITY DATA

Thirty-day mortality for electively operated patients was 5.4%. Of the 10 patients who had emergency surgery, only 2 survived bringing the total 30-day mortality, including rupture to 6.2%, 5.4% in the early-surgery and 7.2% in the surveillance group. Cardiovascular cause of death was 60% in the early-surgery group and 68% in the surveillance group. Myocardial infarction comprised 17% of the former and 19% of the latter group deaths. At the end of 6 months following randomization, the death rate in the early-surgery group was about 2½ times that of the surveillance group. In the subsequent 6 months, the death rate in the early-surgery group was about three fourths that of the surveillance group. The survival curves crossed in favor of early surgery at about 3 years. The death rate in continuing smokers was 3 times that of former smokers.

EXPECTED MORTALITY

The US 1997 population mortality table was used. This table approximates the midpoint of the study. Although the study was in the United Kingdom, using a US mortality table should not produce a significant underwriting variance in comparative mortality. The effect of the difference in racial mix, if any, between the study population (unstated) and the expected table is unknown. The ages of the 2 observed groups were between 60 and 76 years. Mean ages of the 2 groups at
entry were 69.2 ± 4.4 and 69.3 ± 4.4 years. Since these were very similar and the range relatively narrow, *q’* for the mean age of 69 was used at zero time. For each successive interval, the expected cohort was advanced 1 year in age. The male percentage of the 2 observed cohorts was 83.1% and 82.3%. For simplicity a male percentage of 83% was used to determine expected mortality. At the start of the study, aortic aneurysm size in the 2 observed groups was 4.63 ± 0.4 cm and 4.61 ± 0.37 cm. It is unlikely such a small difference affected the mortality outcomes. All expected calculations were rounded to 3 decimal places. (Table 2)

### OBSERVED MORTALITY

The source document illustrated a Kaplan-Meier estimate of overall survival through 8 years for each assigned group. The curve was enlarged to facilitate measurement. This can produce further distortions, which could have an effect on calculations. Using calipers, the height of the early-surgery and surveillance group’s survival was measured at the end of each 1-year interval. By the method of proportions, these measurements were converted into survival percents. Since the survival curve illustrated only 40% to 100%, the remaining percent of the survival curve was calculated and added to establish cumulative survival (*P*) for each yearly interval. From cumulative survival, interval survival (*p*) and mortality (*q*) were calculated. For intervals 0–4, 5–8 and 0–8, 1–4 and 1–8 years, the annual, average, geometric mortality *q* is calculated. All observed survivals were rounded to 3 decimal places. (Tables 3 and 4)

### COMPARATIVE MORTALITY

For yearly intervals 0–1 through 8–9, the mortality ratios were calculated from *qi/qi’* and excess deaths from *qi–qi’*. For multiple year intervals, the annual, average, geometric mortality rates were used in the calculations. Mortality ratios less than 200% were rounded to the nearest 1%; those greater were rounded to the nearest 5%. Excess deaths were rounded to the nearest whole number. (Tables 5 and 6)

### POSSIBLE CONFOUNDING FACTORS AFFECTING RESULTS

The authors noted the age range at entry was 60–76; mean ages were 69.2 ± 4.4 and 69.3 ± 4.4. Based on the narrow standard deviation, a starting age of 69 was used. An older mean age would have produced higher expected mortality and lower mortality ratios and excess death rates. The year-to-year aging of the group can affect the final results.
For this abstract, 1 full year was used. Older-age individuals die at a greater rate thus the mean age of the group may have advanced less than 1 full year. Insufficient information was given to calculate a true mean $q'$. The $q'$ for the mean age based on the starting male/female ratio at zero-time composition was used. One hundred eighty-six (14.6%) patients refused informed consent and were not included in the study. Whether poor health contributed to refusal of participation is unknown. Likely those providing consent for randomization were a more motivated, healthier group. In the follow-up after 1998, 14 surveillance and 1 elective surgery patient underwent endoscopic/laparoscopic repair. Initially the surgeons had little experience with this procedure. However, the authors did not find that the type or date of surgical repair affected the shapes of the survival curves. At the end of follow-up, 39 subjects (33 surveillance, 6 elective-surgery) had not
undergone repair. Their ultimate fate is unknown.

DISCUSSION

Comparative mortality shows an improved 8-year survival in the early-surgery compared to the surveillance group. Not unexpectedly the early-surgery group had a high first-year mortality ratio of 330% and an excess death rate of 64. For the entire 8-year interval, the mortality rate is 170% and excess death rate 28. The surveillance group obviously did not have a high first-year, surgery-related mortality. Their mortality ratio for the 8-year interval was 215%, and excess death rate was 45. The authors noted the hazards ratios after adjustment for covariates were 0.81 and 0.83 in favor of early-surgery compared to surveillance. After 6 months, the death rate in the early-surgery group was about three fourths that of the surveillance group. Due to this early high mortality, the cumulative survival curves did not cross in favor of early surgery until about 3 years.

Based on this comparative mortality study, individuals with aortic aneurysms between 4.0 cm and 5.5 cm in diameter appear insurable. After the first year, participants who had elective surgery had a survival advantage over those undergoing observation. A likely contribution to their survival advantage was an improved life style and health habits post operatively. Whether smaller size aneurysms had a survival advantage over the larger ones in the 2 groups cannot be ascertained. Aneurysms greater than 5.5 cm comprised most of the deaths. The risk of rupture was 4 times greater in females.

In the early-surgery group after excluding the first-year interval from the first 4 full years of observation, the mortality ratio decreased from 194% to 170%. Excess deaths decreased from 31 to 19. Over the entire 8-year duration, exclusion of the first-year interval improved the mortality ratio from 170% to 160% and excess deaths from 28 to 22.

Mortality ratios and excess death rates must be interpreted in the context of the age of the study population. The mean age of this cohort was 69 years. The relatively low mortality ratios can be deceiving. With a constant observed mortality rate or deaths as the age increases, the expected mortality rate or deaths increase thus decreasing the mortality ratio. A truer mortality assessment in this population is the excess death rate, which is high compared to the mortality ratios. Postoperative individuals have high first-year mortality. If surgery is contemplated or the aneurysm is greater than 5.5 cm, postponement of insurability is advisable. Confounding the underwriting of small aortic aneurysms is their common coexistence with other atherosclerotic-related impairments such as cerebral, peripheral and coronary arterial disease. The authors noted diameter of the aneurysm is an independent marker of the risk of cardiovascular disease. The overwhelming cause of death in both groups was cardiovascular – 60% in the early-surgery and 68% in the surveillance. Smoking is a major risk factor in the survival of persons with aortic aneurysms, increasing the death rate by a 3-fold factor. Those who ceased smoking or were former smokers had an improved survival compared to current smokers. There was a higher rate of smoking cessation in those who underwent early surgery.

REFERENCE