Outcomes after Abdominal Aortic Aneurysm Repair in Those ⩾80 Years of Age: Recent Veterans Affairs Experience

Andris Kazmers, MD, MSPH, Anthony J. Perkins, MS, and Lloyd A. Jacobs, MD, Detroit, Michigan

During fiscal years 91-95, 6260 patients underwent 6269 abdominal aortic aneurysm (AAA) repairs in Veterans Affairs Medical Centers. Those ⩾80 years old comprised 3.7% (n = 231) of the patients. A total of 5833 patients underwent repair of nonruptured AAA: mortality was 4.1% (228/5627) in those <80 and 8.25% (17/206) in those ⩾80 years old (p < 0.009). Logistic regression analysis indicated age ⩾80 was independently associated with higher mortality (odds ratio 1.834:1, 95% bounds 1.117-3.012). Octogenarian status (defined as ⩾80 years of age), however, had a less important association with in-hospital death than did surgical complications of the heart or genitourinary tract, postoperative hemorrhage, septicemia, respiratory insufficiency, myocardial infarction (MI), acute renal failure, surgical complications of the central nervous system (CNS), aneurysm rupture, postoperative shock, or disseminated intravascular coagulation (DIC), in ascending order of importance. Only 5.9% (n = 25) of the 427 patients undergoing repair of ruptured AAA were ⩾80 years old. In those ⩾80 undergoing repair of ruptured aneurysms, mortality was 48% which did not differ from the 45% mortality in those <80 (NS). The likelihood that one would be operated for rupture was statistically greater (1.66:1) for those ⩾80 years (p < 0.025). Length of stay (LOS) for those ⩾80 undergoing AAA repair was longer being 22.3 ± 14.8 days versus 18.3 ± 13.2 days for younger patients (p < 0.001). Mortality and LOS after AAA repair were statistically greater for those ⩾80 years of age. Severity of illness, however, was also greater for octogenarians. Patient Management Category (PMC) software defined illness severity was 4.06 ± 1.22 in octogenarians versus 3.84 ± 1.13 for those younger (p < 0.005). Though age ⩾80 was independently associated with increased mortality, selected elderly patients could benefit from AAA repair. (Ann Vasc Surg 1998;12:106-112.)

INTRODUCTION

Mortality rates after elective abdominal aortic aneurysm (AAA) repair in octogenarians have ranged from 0% to 9.6%.[1-13] Some octogenarians with an AAA are not offered aneurysm repair due to the increased risk of surgery and to the notion that there may not be as much survival benefit in this elderly population.[4] Life expectancy for octogenarians, however, is sufficiently long that aneurysm rupture would likely claim many octogenarians

From the Division of Vascular Surgery, Wayne State University School of Medicine (A.K.), Ann Arbor Health Services Research & Development, Department of Veterans Affairs (A.J.P.), and the University of Michigan School of Medicine (L.A.J.), Detroit, MI.

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Correspondence to: A. Kazmers, MD, MSPH, Division of Vascular Surgery, Wayne State University, Harper Hospital, 3990 John R, Detroit, MI 48201, USA.

who have unrepaired AAA.[14] In this study, outcomes for octogenarians with AAA treated surgically in Veterans Affairs Medical Centers (VAMCs) were compared to outcomes for younger veterans. Outcomes after AAA repair have been previously reported for the VA patient population.[15]

MATERIALS AND METHODS

Methods used in this study were similar to those used previously.[15,16] Abstracted data from the Veterans Affairs Patient Treatment File (PTF) were obtained for patients in DRGs 110 and 111 (Major Cardiovascular Procedures with or without complications and comorbidity) for fiscal years 91, 92, 93, 94, and 95. Each episode of in-patient care in VAMCs for those years was entered and maintained in the PTF. For each hospitalization, the first 10 diagnoses and first 20 procedures defined using International Classification of Diseases (ICD-9-CM) codes were available from the PTF. Patients in DRGs 110 and 111 were identified from the PTF database, and specifically those undergoing AAA repair were selected for further study. Abstracted PTF data pertaining to the hospitalization during which AAA repair was performed were further analyzed using Patient Management Category (PMC) software.[15,16] PMC software was used to generate a measure of illness severity and to provide a relative intensity score (RIS), the latter served as a measure of resource utilization.[15,16] PMC software also assigned Patient Management Categories (PMCs). The number of PMCs assigned to a patient served as an indicator of patient complexity.[15,16] Veterans undergoing repair of nonruptured AAA (n = 5833) were assigned to PMC 4117 while those undergoing repair of ruptured AAA (n = 427) were assigned to PMC 4119. Patients could be assigned to other PMC categories as well, including complication PMCs.[15,16]

Study data also included age, length of stay, and postoperative complications defined by ICD-9-CM complication coding. ICD-9-CM complication codes entered into logistic regression analyses included those for postoperative shock, hemorrhage complicating an operative procedure, surgical complications of the central nervous system (CNS), surgical complications of the heart, surgical complications of the peripheral vascular system, surgical complications of the respiratory system, surgical complications of the gastrointestinal tract, and surgical complications of the genitourinary tract.

Specific complication PMCs that were analyzed included those for septicemia, respiratory insufficiency or failure, disseminated intravascular coagulation (DIC), and septic, cardiogenic, or traumatic shock. PMC categories 0301 through 0308 were used to define acute myocardial infarction (MI). Acute renal failure (ARF) was present in patients included in PMCs 0703 and 0704, which represented acute renal failure with, and without dialysis, respectively. The ICD-9-CM codes used in this study were codes specifically assigned to postoperative complications. PMC complication codes were not specifically defined as postoperative complications, but represented complications that occurred at some time during hospitalization.

Data were analyzed using SAS and Systat statistical software. Logistic regression analysis was used to define parameters independently associated with mortality after AAA repair.

RESULTS

During fiscal years 1991-1995, 6260 patients underwent 6269 AAA repairs in VAMCs. Nine patients underwent aortic reoperation for AAA, and these reoperative procedures were excluded from analysis. Mean age for the group of study patients was 68.4 ± 6.6 with a median age of 69 years. Those ⩾80 years old comprised 3.7% (n = 231) of all patients undergoing AAA repair. For the 231 patients who were ⩾80 years of age, age ranged from 80 to 104 years with a mean of 82.3 ± 3.1 years with a median of 81 years of age. Only six patients were 90 or more years of age. For the purposes of this study, those ⩾90 years of age were also included in the ''octogenarian'' classification (i.e., all patients ⩾80 years of age).

A total of 5833 patients underwent repair of nonruptured AAA during the 5-year period: mortality was 4.1% (228/5627) in those <80 years while mortality was 8.25% (17/206) in those ⩾80 years of age ($p < 0.009$). Mortality after repair of nonruptured aneurysms in those ⩾80 was 6.3% (9/143) if there were no postoperative complications compared to 12.7% (8/63) for octogenarians with complications ($p > 0.15$, NS).

Length of stay (LOS) for those ⩾80 undergoing AAA repair was 22.3 ± 14.8 days, which was longer than the 18.3 ± 13.2 days LOS for younger patients ($p < 0.001$). For all patients undergoing AAA repair, LOS was 5.4 days longer for those with any postoperative complication (22.4 ± 16.3 days with, versus 17.0 ± 11.7 days for those without; $p < 0.001$).

A total of 427 patients underwent repair of ruptured AAA, but only 5.9% (n = 25) of these latter patients were ⩾80 years old. Mortality rate in those ⩾80 undergoing repair of ruptured aneurysms was 48%, which was similar to the 45% mortality for

Table I. Complications after repair intact AAA

n = 5833	<80 years (%)	⩾80 years (%)
ICD-9-CM complications		
Postoperative shock	0.25	0
Postoperative hemorrhage	4.0	5.3
CNS	0.55	0.49
Heart	6.2	9.2
Peripheral vascular	0.96	2.4
Respiratory	5.6	9.2
GI	4.5	5.3
GU	1.7	1.5
PMC-defined complications		
Sepsis	1.5	2.4
Respiratory failure or insufficiency	2.1	0.97
DIC	0.27	0.49
Septic, cardiogenic, or traumatic shock	0.27	0
Myocardial infarction	1.8	2.4
Acute renal failure	1.5	1.5

Comparison of the frequency of complications in octogenarians versus those younger undergoing repair of intact AAA. ICD-9-CM coded complications included surgical complications of the central nervous system (CNS), heart, peripheral vascular system, respiratory system, gastrointestinal (GI) system, and genitourinary (GU) system. PMC software defined Patient Management Complication Categories include among others, disseminated intravascular coagulation (DIC) and acute myocardial infarction.

those <80 years of age (NS). The likelihood that one would be operated on for rupture was statistically greater for those ⩾80 years ($p < 0.025$). In octogenarians, the odds that an operation would be done for rupture was 1.66:1 compared to those <80 years old.

Severity of illness was greater for the octogenarians. For the latter group of patients, PMC software defined illness severity as 4.06 ± 1.22 versus 3.84 ± 1.13 for those <80 years of age ($p < 0.005$). Resource intensity was also greater for the octogenarians: RIS was 3.24 ± 0.60 in octogenarians versus 3.11 ± 0.60 for those younger ($p = 0.002$). Differences in PMC count approached a significant difference for octogenarians, being 2.93 ± 1.26 versus 2.78 ± 1.33 ($0.05 < p < 0.10$) in those <80 years of age.

In veterans undergoing repair of nonruptured AAA ($n = 5833$), the incidence of postoperative shock, hemorrhage complicating an operative procedure, surgical complications of the CNS, heart, gastrointestinal tract, genitourinary tract, acute renal failure, acute myocardial infarction, septicemia, respiratory insufficiency, and DIC were not higher in octogenarians (Table I). Differences in incidence of surgical complications of the peripheral vascular system and respiratory system in octogenarians approached but did not attain statistical significance ($0.05 < p < 0.10$).

A logistic regression model, which included all patients who underwent AAA repair ($n = 6260$), revealed that age ⩾80 was associated with higher mortality, but octogenarian status appeared to have less of an association with in-hospital mortality (lower odds of death) than did surgical complications of the heart or genitourinary system, hemorrhage complicating an operative procedure, septicemia, respiratory insufficiency, acute myocardial infarction, acute renal failure, surgical complications of the CNS, aneurysm rupture, postoperative shock, or disseminated intravascular coagulation in ascending order of mortality risk (Table II). Age ⩾80 was independently associated with higher mortality (odds ratio 1.834:1, 95% bounds 1.117 to 3.012). Aortic aneurysm rupture, however, was a much stronger risk factor for death. Odds of death for all patients undergoing AAA repair was 15.3 times greater (95% bounds 11.7 to 19.8) in those with aneurysm rupture.

DISCUSSION

The natural history of AAA is to enlarge and rupture, and this process is interrupted only if the patient first dies of another cause. Aneurysm repair may not be offered to patients if the risk of surgery is considered to be excessive.[17-20] It is not unusual for the risk of elective AAA repair to be overesti-

Table II. Logistic regression model: mortality = dependent variable

n = 6260	Odds ratio	95% bounds	
		Lower	Upper
Octogenarian status	1.834	1.117	3.012
Surgical complication: heart	2.185	1.546	3.087
Surgical complication: genitourinary	2.322	1.319	4.086
Postoperative hemorrhage	2.325	1.503	3.598
Septicemia	3.273	1.903	5.630
Respiratory failure or insufficiency	3.906	2.399	6.360
Myocardial infarction	6.129	3.785	9.926
Acute renal failure	7.082	4.435	11.309
Surgical complication: CNS	7.530	3.220	17.611
AAA rupture	15.253	11.730	19.835
Postoperative shock	17.899	6.026	53.165
Disseminated intravascular coagulation	18.552	6.200	55.518
Septic, cardiogenic, or traumatic shock	20.060	7.410	54.304

Logistic regression analysis with mortality as dependent variable was done for all veterans undergoing AAA repair. The odds of death are shown for each factor found to be associated statistically with in-hospital mortality after aneurysm repair. Also shown are the associated 95% confidence limits for the various odds ratios.

mated, particularly in the elderly.[4,17] One of the most common causes of death for those with untreated AAA has been aneurysm rupture, even when these patients have significant comorbidities.[2,18,19] Since AAAs behave erratically, elective repair should be considered for each patient with an AAA in order to prevent aneurysm rupture. If repair is not offered, the medical conditions responsible must be very ''serious.''[20] Mortality outcomes following elective repair of AAA in VAMCs have been comparable to those achieved in the private sector in the United States and Canada.[15] Such crude mortality rates overlook important information, however, and are insensitive to the age and medical status of the individual patients. Increasing age has been associated with greater mortality after AAA repair, and this study is no exception.[15] This study, however, shows that severity of illness was also higher in octogenarians. The confounding effects of increasing age versus age-associated comorbidities on outcomes after AAA repair remain blurred.

It is unclear whether there is a theoretical age maximum at which point there is likely to be little survival benefit from elective aneurysm repair. From a practical standpoint, only six veterans 90 or more years of age underwent AAA repair during the 5-year study in all VAMCs. Patients 90 or more years of age comprised less than 0.1% of the patients in this study. Others have reported previously that repair of aneurysms in nonagenarians has likewise been infrequent. In the Netherlands, 0.99% of ruptured AAA treated surgically were nonagenarians, while only 0.078% of those undergoing repair of nonruptured AAA were nonagenarians.[21] Those 90 years old or greater are infrequently considered to be candidates for elective AAA repair. The age at which there appears to be an ill-defined cutoff for referral of patients for elective AAA repair may even be lower than 90 years of age. In a report of one statewide experience with AAA repair, there were no Medicare patients over 84 years of age in 1983 who underwent elective AAA repair.[22]

Doubt has recently been raised about the advisability of surgery for octogenarians even with ruptured AAA.[22] One study reported a 90% mortality rate after AAA rupture in octogenarians.[19] A suggestion that repair not be offered to patients with such a slim chance of survival generated a great deal of controversy.[23,24] One approach to those with ruptured AAA would be to attempt repair if there remained any sign of life, even if the patient were elderly.[7] Mortality is 100% for those with ruptured AAA treated nonoperatively.[6] A number of centers reported lower mortality rates after AAA rupture in the elderly than those experienced at Harborview Hospital.[2-7,9-17] The present study suggests that attempts to repair ruptured AAA appear warranted, even for octogenarians. In veterans, mortality rates after repair of ruptured AAA in those 80 or more years of age were comparable to mortality rates experienced by those younger. This finding was counterintuitive and was not explained by the available data. Others have similarly re-

ported that outcomes of octogenarians with ruptured AAA were comparable to outcomes for those younger.[9,13] Despite this, other centers have corroborated the 90% or greater mortality rate experienced at Harborview Hospital in Seattle after repair of ruptured AAA in octogenarians.[8]

There were relatively few octogenarians undergoing aneurysm repair in this study which included all patients in all VAMCs undergoing AAA repair over the span of 5 years. An average of less than 50 AAA repairs per year nationwide were done in VAMCs in those 80 years or older. This is surprising since the incidence of AAA increases with age, reaching a maximum in the 80s.[25] The incidence of AAA rupture also increases with age. In one statewide study, the frequency that aneurysms were repaired electively increased over time as did the number of ruptured aneurysms treated annually.[26] In one statewide experience of Medicare patients undergoing AAA repair, 13% undergoing elective repair were octogenarians.[22] One wonders whether the greater severity of illness noted in veterans compared with the private sector resulted in a lower likelihood that such patients would be referred for AAA repair.[27] It is not likely that this finding is related to an ongoing study of patients with AAA within VAMCs who might be randomized to nonoperative repair since the latter study excludes those 80 or more years of age.[28] It is possible that the overall pool of octogenarian veterans with AAA may be quite small. At this time it is unknown which factors might be responsible for the low volume of AAA repairs performed in octogenarians in VAMCs. The number of veterans, octogenarian or younger, who had AAA and were denied repair is also unknown. Data were not available from the PTF about aneurysm size in veterans undergoing AAA repair.

Mortality, LOS, and utilization of resources after AAA repair were statistically greater for those $\geqslant$80 years of age. Despite the fact that age $\geqslant$80 was associated independently with increased operative mortality, disease severity was also found to be greater for octogenarians undergoing AAA repair. The risk of death after elective AAA repair was not so great in octogenarians, however, to negate the potential survival benefit that follows successful repair. Selected elderly patients could theoretically benefit from elective AAA repair so as to prevent death from AAA rupture. The elective mortality rate for octogenarian veterans undergoing AAA repair was comparable to if not lower than the overall mortality rates reported for severe statewide experiences with AAA repair.[15] Though some clinical factors as well as preoperative studies help predict risk of surgery, it remains difficult to predict an individual's ability to tolerate AAA repair.[29] The optimal work-up and preparation for octogenarian patients who need AAA repair have not been defined. In the present study, the incidence and number of complications were not higher for octogenarians undergoing repair of intact AAA compared to younger patients. The mortality rate for octogenarian veterans undergoing repair of intact and ruptured AAA who had complications was 19.7% versus a 9.4% mortality rate for those without complications ($p < 0.035$). If ruptured AAA were eliminated from analysis, however, there would no longer be a significant difference in mortality rates for octogenarians who did have complications after repair of intact AAA versus those who did not (6.3% mortality rate). Perhaps the best way to avoid fatal complications after AAA repair in octogenarians would be to avoid emergent repair of ruptured AAA. Aneurysm rupture was indeed responsible for 59% of the deaths in one study of octogenarians with AAA who were denied AAA repair.[2] Clearly one should strive to detect and electively repair significant AAA in patients at a younger age.

Some octogenarians are not referred for elective aortic aneurysm repair because their physicians think there is little survival benefit. Life expectancy for those 80 years of age is 6.3 years.[14] Treiman et al., reported a 3-year survival rate of 52% in octogenarians who survived elective aneurysm repair. Of these latter patients, 93% returned to their preoperative health status within 6 months of AAA repair.[3] O'Donnell reported that 86% of octogenarians undergoing elective AAA repair had regained their preoperative status at 1 year versus 60% of those who survived repair of ruptured AAA.[2] One group reported the quality of life for those surviving AAA repair was comparable to that of normal subjects.[30]

Five-year survival was 48% in octogenarians surviving AAA repair at the Cleveland Clinic.[11] Survival in these latter octogenarians surviving AAA repair was lower than that for normal subjects.[11] Further, survival was favorably influenced by prior myocardial revascularization, which increased 5-year survival to 80%.[11] One group reported 67% 5-year survival for octogenarians managed electively versus 34% for those managed emergently.[12] The highest survival rate reported after elective AAA repair in octogenarians was 85.7% survival at 5 years.[13]

Despite the fact that age $\geqslant$80 was associated independently with increased operative mortality, it is likely that selected elderly patients could benefit

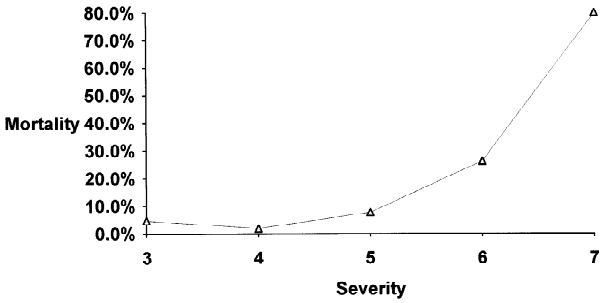

Fig. 1. Relationship of in-hospital mortality with PMC software-derived illness severity for octogenarians undergoing repair of intact aneurysms in VAMCs (n = 206).

from elective AAA repair so as to prevent death from rupture. Octogenarian status was far less of a risk factor for death than was aneurysm rupture in the present study. It would appear that lives could be prolonged by taking an appropriately aggressive approach to AAA repair in those 80 or more years of age who are fit for surgery. One can expect that octogenarians facing AAA repair will likely have greater illness severity than those younger. In-hospital mortality is related to illness severity in octogenarians. In this study, octogenarians with PMC defined illness severity ⩽4 had only a 3.85% in-hospital mortality rate after repair of intact aneurysms (Fig. 1). There is little guidance available regarding what aneurysm size should be treated by elective surgical repair and what size might be better observed in the very elderly patient. Attempts at repair of ruptured AAA in such elderly patients should not be avoided, however, since adverse mortality outcomes are not experienced universally.

In the present study, 91.75% of octogenarians survived hospitalization after repair of intact aneurysms and 52% survived repair of a ruptured aneurysm. If one assumed that all octogenarians who were denied AAA repair died of aneurysm rupture, only two to three (2.5) octogenarian veterans would need to be treated electively to prevent one death from aneurysm rupture in a ''number needed to treat analysis,'' given the survival rates observed in this study.[31] If one assumed that 50% of octogenarians with AAA who were denied repair died of ruptured aneurysms, a reasonable estimate, then five to six (5.6) patients would need to undergo elective AAA repair to prevent one death from rupture.[2] Given these considerations, it is reasonable to recommend that more octogenarians with AAA should be seriously considered for elective AAA repair.

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