Outcomes in Nonagenarians After Heart Valve Replacement Operation

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Background. Changes in the age profile of the United Kingdom population and improvements in preoperative and postoperative care have resulted in increasing numbers of very elderly patients undergoing heart valve replacement (HVR) operations. Although HVR operations in nonagenarians are relatively uncommon, the demand for cardiac operations in this age group may increase over time. Outcomes after HVR operations in nonagenarians have not been well described yet. Therefore, the aim of this study was to determine outcomes in terms of early mortality and long-term survival in 35 nonagenarians after HVR operation.

Methods. Data from the United Kingdom Heart Valve Registry were analyzed and nonagenarian patients were identified. Additional analyzed data include gender, valve position, valve type, valve size, operative priority, follow-up time, and date and cause of death. Kaplan-Meier actuarial curves were calculated to determine accurate 30-day mortality and long-term survival.

Results. On average five HVR operations are performed annually in the United Kingdom in nonagenarians with equal numbers of males and females. Aortic valve replacement with a bioprosthetic valve was the most common operation and 86% were elective admissions. Fourteen patients died within the review period; mean time to death was 402 days. Overall 30-day mortality was 17%, which was higher for males compared with females; females also displayed better long-term survival.

Conclusions. HVR operations in nonagenarians carry a significantly higher risk of early mortality and reduced long-term survival. Despite increases in the age profile of the population, elective HVR operation with patients aged 90 years or older is likely to remain an infrequent surgical procedure reserved for very carefully selected patients.

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Parallel with many other countries, the age profile of the United Kingdom (UK) population has changed markedly over the last 50 years in terms of life expectancy and the proportion of elderly within the overall population. Patients aged 60 years and older in the UK account for one-fifth of the total population. However, it is estimated this will have risen to one-third by the year 2030 [1] with those aged 80 years or older accounting for the fastest growing sector of the population [1]. Despite a higher prevalence of comorbid conditions (an expected progressive severity of heart diseases and age as an independent risk factor for cardiac operation in the elderly) there has been a significant increase in the average age of patients undergoing first-time heart valve replacement (HVR) in the UK as well as the number of elderly undergoing HVR operations. Between 1986 and 2000 the average age at operation for first-time HVR operation in the UK rose from 59 years to 66 years. [2] Moreover, the proportion of elderly (ie, aged 70 years or older) increased more than threefold from 12% to 40% during the same period [2].

Studies evaluating the outcomes of HVR operations in the elderly have reported encouraging results [3–20] However these studies have focused mainly on patients whose ages are in their seventies and eighties and, although a few studies have included patients who are in their nineties [3–13], very few have specifically looked at the outcomes of cardiac operations in nonagenarians separately [21–24]. It is known that HVR operations have been performed in a small number of patients aged 90 years and older in the UK (UK HVR, unpublished data) and the United States [22, 24]. Estimates predict that by the year 2031 there will be approximately 34,000 centurions (ie, elderly aged 100 years or older) in the UK alone [1], and we may expect to see an increase in potential cardiac operation candidates and in the numbers of nonagerians being referred. As expectations of both referring physicians and patients constantly change, it is necessary to evaluate the outcomes after operation in this particular patient population. The aim of this study was to determine the 30-day mortality outcomes (ie, deaths within 30-days of operation irrespective of whether the death occurs in-hospital or after discharge to home or another care facility) and long-term survival of a group of patients aged 90 years or older who underwent initial HVR operations in the UK.

Material and Methods

The data source was the UK Heart Valve Registry database. The UK Heart Valve Registry, which began in 1986 and was based at the Hammersmith Hospital London, is a national database that prospectively collects data from all UK cardiac surgical centers. Certain preoperative, implant, and postoperative data are collected for all patients who undergo HVR operations in the UK. All patients are followed up for the occurrence of death by the national agencies responsible for registering all deaths of UK residents and nationals (ie, the Office for National Statistics [England & Wales], the General Register Office [Scotland], and the Central Services Agency [Northern Ireland]). These agencies return a copy of the patient's death certificate to the Registry, which includes date, place, and certified cause of death, and identifies those patients who underwent postmortem autopsy. The Registry also receives precise implant details for all patients registered in the database.

Between January 1, 1986 and December 31, 2000, 35 patients aged 90 years or older at operation underwent initial heart valve replacements in the UK and were registered on the UK Heart Valve Registry database. Analyzed data included patient age, gender, valve position, type of valve implant, valve size, operative priority, follow-up time, and date and cause of death. Kaplan-Meier actuarial survival curves were calculated to determine 30-day mortality and long-term survival.

A review of the clinical notes for 18 patients (it was not possible to obtain the medical records for all 35 nonagenarian patients included in the study) was conducted in order to assess pre-clinical status and determine how nonagenarians compare with younger HVR patients in terms of concomitant procedures, length of hospital stay, hospital morbidity, postoperative complications, and quality of life after the operation.

Results

Patient Population

Between January 1, 1986 and December 31, 2000, 79,758 consecutive patients underwent initial HVR operations and were registered with the UK Heart Valve Registry database. Of these patients, 35 (0.05%) were aged 90 years or older at the time of implant. The study was 97% complete with 2,044 patients lost to follow-up, giving a total number of 412,569 patient follow-up years.

The first registered HVR operation on a UK patient aged 90 years or older was performed in 1988. Between 1988 and 1995 there was an average of one HVR operation carried out annually in this age group (range, one to three operations per year). However, since 1996 the mean number of HVR operations performed annually has risen to five (range, three to seven operations per year). Nonetheless, this still only represents less than 1% of the total annual valve replacements carried out in the UK (UK HVR, unpublished data). The mean age at operation was 91 ± 1.3 years (range, 90 to 95 years). There were similar

Table 1. 30-Day Mortality and Long-Term Survival in Nonagenarians After First-Time Heart Valve Replacement Operation

	≤ 70 Years (%)	70–80 Years (%)	80–90 Years (%)	≥ 90 Years (%)
Overall				
30-day mortality	3.66	6.07	7.52	17.14
1-year survival	93.22	89.36	86.90	74.29
2-years survival	91.54	86.84	83.27	74.29
Females				
30-day mortality	4.20	5.99	7.68	11.11
1-year survival	93.25	90.15	87.59	77.78
2-years survival	91.63	88.27	84.29	77.78
Males				
30-day mortality	3.43	6.14	7.30	23.53
1-year survival	93.20	88.74	85.98	70.59
2-years survival	91.50	85.73	81.90	70.59

numbers of females and males (ie, 18 and 17, respectively). Thirty-four patients underwent single valve replacement. Thirty-two aortic valves (AVR), two mitral valves, and one double valve (mitral valves plus AVR) were replaced. Thirty-one patients received bioprosthetic implants, 22 that were porcine valves and nine that were pericardial bioprostheses. Mechanical valves were implanted in 4 patients, bileaflet valves were implanted in 2 patients, a single leaflet valve in 1 patient, and a ball valve in another patient. Elective admissions accounted for 31 patients, urgent admissions for 3, and an emergency admission for 1.

Mortality

Fourteen patients (40%) died within the period reviewed. The mean time to death was 402 days (range, 0 to 2,610 days). Seven patients died from cardiac-related causes (n = 5, cardiac failure; n = 2, myocardial infarction). Noncardiac-related causes of death included pneumonia (n = 4), hemorrhage (n = 1), cerebrovascular accident (n = 1), and accident trauma (n = 1). One patient admitted as an urgent case died 3 days after operation from cardiac failure. All other deaths occurred in patients who underwent elective HVR operation. Of the 2 patients who underwent mitral valves, 1 died on the day of operation, and the other patient remains alive at 1,507 days. The only patient to undergo double valve replacement died at 3 days postoperatively. There were no deaths in patients with mechanical heart valve prostheses (mean survival time, 1,794 days). Overall 30-day mortality was 17%, which was significantly higher for males compared with females ($p < 0.000$; Table 1).

Additional Clinical Information Obtained From Case Notes on 18 of 35 Patients

All 18 patients had AVR, of which 6 patients had concomitant coronary artery bypass grafting. Twelve of the patients had a preoperative diagnosis of aortic stenosis that was confirmed at operation. The mean preoperative systolic aortic gradient was 75 mm Hg (range, 35 to 100

mm Hg). Five patients had AVR plus coronary artery bypass grafting; 2 patients underwent AVR and mitral valve repair; and 1 patient had AVR, coronary artery bypass grafting, and repair of an ascending aortic aneurysm. All 18 patients suffered from dyspnea (New York Heart Association grade II-IV), and 5 of these patients also had angina (New York Heart Association grade II-IV). During operation the mean cardiopulmonary bypass time was 95 minutes (range, 28 to 135 minutes). The average length of stay in the hospital was 18 days ($\pm$ 12 days, range 7–55 postoperative days). Major postoperative morbidity was reported in 14 patients (77%). Two patients suffered from cardiac tamponade with 1 patient dying as a result of the event. Four patients had atrial fibrillation develop, and all were successfully cardioverted, but 1 patient went on to suffer a fatal cerebrovascular accident. Other recorded postoperative complications included bronchopneumonia (n = 2), chest infection (n = 2), renal dysfunction (n = 1), and heart block requiring permanent pacemaker insertion (n = 1).

Clinical follow-up of the 14 patients discharged from the hospital (mean = 5.2 months) indicated 4 patients who experienced a further recurrence of atrial fibrillation, 4 patients who suffered from shortness of breath upon minimal exertion, and 1 patient who continued to suffer from severe and marked ankle edema. Otherwise, all patients continued to do well, remained mentally fit, and said that they were pleased with the results of the operation.

Comment

Despite earlier reservations to perform cardiac operations in patients aged 70 years or older because of the perception of carrying a prohibitively high mortality risk, the demand for cardiac operations in elderly patients has steadily increased over the last 10 to 15 years. As the upper age limit and proportion of elderly patients undergoing cardiac operations continues to rise, surgeons will be asked more often to evaluate the possibility of surgical intervention for valvular heart disease. Ten years ago cardiac operations in patients aged 80 years and older was relatively uncommon [2]. Since then there has been a marked increase in the number of operations performed in this age group and an increase in the number of concomitant publications reporting on the outcomes of HVR operations in the very elderly. It is evident that the increased risks to patients in these age categories are considered acceptable compared with those in the younger age groups. Advancing age subjects the heart to fibrosis and calcification such that senile aortic stenosis is one of the most prevalent valvular lesions in the elderly, but this may be relatively well tolerated in patients who are otherwise fit, despite their years. Mitral valve disease, by contrast, is known to be less well tolerated with patients generally more compromised in terms of cardiopulmonary function. Thus, it is of no surprise that aortic valve replacement was, by far, the most common operation in these patients (32 of 35).

Thirty-day mortality in elderly patients has been reported, ranging from 2% to 18% for single AVR without concomitant procedures and 6% to 19% for combined AVR and coronary artery bypass grafting [3–9, 11–16, 19–24]. Some of these studies have included patients aged 90 years and older, suggesting early mortality falls within acceptable levels. The few studies that have separately examined the outcomes of cardiac operations in nonagenarians report a 30-day mortality of between 7% and 18% in patients who have undergone coronary revascularization and zero 30-day mortality in patients who have undergone valve replacement only (n = 15) [21–24]. This compares with a 30-day mortality of 17% recorded overall in our study and 11% for combined AVR and revascularization that falls within the margins of acceptability. However, when compared with younger elderly patients (ie, aged 70 to 89 years; UK HVR unpublished data) we note that early mortality in nonagenarians is significantly higher ($p < 0.000$) (Table 1, Fig 1). Contrary to studies reporting gender-related early mortality being higher in females, the females aged 90 years and older in this study demonstrated a lower than or equal to 30-day mortality compared with males ($p < 0.000$; Table 1) [8, 9, 14]. Overall cumulative survival remained the same at 1 and 2 years (ie, 74%) (Table 1). When examined within the context of gender, females displayed better long-term survival than males, which supports the existing research findings in other age groups (Table 1) [8, 9, 14].

Bioprosthetic valves are recommended for heart valve replacement in the elderly because they may avoid the need for long-term anticoagulation and therefore reduce the related risks to the patient. In addition, reports have shown bioprostheses have a slower rate of structural valve deterioration in the very elderly [25, 26]. Not surprisingly therefore, more than three-quarters of all valves implanted (ie, 89%; 32 of 36) were bioprostheses. Although there is a preference for bioprosthetic valves for the reasons already mentioned, all deaths occurred in patients with bioprostheses. All 4 patients with mechanical valve implants remain alive. However, because markedly fewer patients in this study received mechanical valves, it is difficult to draw any firm conclusions at this stage with regard to the outcomes of implanting either valve type in this patient population.

Emergency admission in the very elderly has been shown to be an independent predictor of early mortality [3, 8]. However, our study does not support this finding as all early deaths occurred in patients admitted electively. However, only 4 patients were admitted on an emergency or urgent basis. Thus it is difficult to draw any definitive conclusions based on such a small sample size.

In-hospital morbidity, as recorded in the clinical notes, occurred in the majority of patients regardless of whether they underwent AVR with or without a concomitant procedure, or of whether they were an elective or emergency admission. Seventy-seven percent of patients experienced postoperative complications. This is comparable with 71% reported by Samuels and colleagues [22], who similarly assessed the outcomes of cardiac opera-
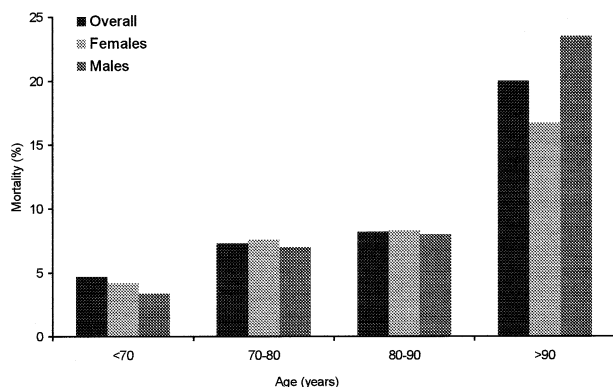
Fig 1. Thirty-day mortality in elderly patients.

tions in nonagenarians. However, compared with younger elderly patient populations, in-hospital morbidity is higher than that of younger elderly patients (59% to 69%) [3, 6, 14]. Thus, nonagenarians are more likely to experience postoperative complications, and as a consequence, a prolonged in-hospital and intensive therapy unit stay [3, 5, 11, 18, 21, 22].

The key questions to consider when determining surgical intervention in the very elderly are: (1) What are the benefits? and (2) Will the operation provide a meaningful extension of life in terms of improving symptoms and quality of life? Assessments of postoperative quality of life in this study were not measured according to a validated scale; assessments can only be reported from the patient's subjective comments as recorded in the clinical notes. According to patient's comments during follow-up review sessions with their clinician, it is apparent that their overall quality of life had improved and that they felt physically and emotionally better after their operation.

In studies that examined the outcomes of AVR in elderly patients (ie, aged 70 years or older), including unpublished data from the UK HVR database, cumulative survival at 1 year ranged from 83% to 93% [3–9, 11–16, 19–24]. However, these survival figures must be viewed with a degree of caution and surgeons must not automatically accept these results as a reflection of the outcomes of valvular operations in nonagenarians. Differences in patient selection and inclusion of younger elderly patients with better survival rates than their more elderly counterparts may influence survival figures. Thus, when all other age groups are excluded from our study for example, survival at 1 year was 74% (Table 1).

In summary, this study evaluated the outcomes of valvular operations in 35 UK patients aged 90 years or older at the time of their operation. Despite limited information on these patients' pre-clinical status, knowledge of in-hospital length of stay, morbidity, functionality, and postoperative quality of life for patients who were discharged, this study presents an accurate 30-day and long-term survival. Heart valve replacements in patients older than 90 years of age are not commonly performed. Our data indicate that in the UK population,

on average around five such procedures are carried out annually mainly as a result of aortic valve stenosis. In-hospital morbidity and mortality (including all 30-day mortality), and mean length of in-hospital and ITU stays in this group of patients were significantly higher, and long-term survivals were lower compared with patients whose ages were in their seventies and eighties. Thus, although the UK in common with many other countries is seeing a marked increase in the age profile of its population, it seems likely that elective heart valve replacement procedures in nonagenarians will remain an infrequent surgical procedure, focused on the aortic valve, and reserved for very carefully selected patients.

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