

# Cardiac Surgery in Nonagenarians: An Institutional 20 Year Experience

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## 1. Abstract

**1.1. Purpose:** We sought to determine the hospital mortality, post-operative outcomes and three-year survival in nonagenarian patients who underwent open heart surgery in the past 20 years in comparison with the younger surgical population.

**1.2. Methods:** We performed a retrospective analysis from a prospectively collected database of all nonagenarians who underwent open heart surgery at Royal Papworth Hospital over the past 20 years (1998-2018). The patients were stratified into three groups according to the type of surgery performed. Survival analysis was done using Kaplan Meier estimation and compared using log rank statistics.

**1.3. Results:** During the study period 95 nonagenarians had open heart surgery performed in our institution (mean age 91.2 years, range 90 - 96). They made up 0.5% of our cardiac surgical population, with a higher mean logistic European system for cardiac operative risk evaluation score (Euro SCORE) of 22.8 vs 9.14 for the younger patients. Overall, in hospital mortality rate was 8.4% compared with 2.4% among the younger patients. Nonagenarians had a longer hospital length of stay and a higher rate of post-operative complications. Among the 87 patients who were discharged, the 3-year survival rate was 32.3%.

**1.4. Conclusions:** This study reports a higher rate of peri-operative morbidity and mortality among nonagenarians. However, evidence from previous studies suggests that cardiac surgery should continue to be performed on the basis of symptomatic improvement. During decision making and resource allocation, it should be recognised that this patient group has a higher rate of peri-operative morbidity and mortality, with a low 3-year survival rate.

**2. Keywords:** Cardiac surgery; Nonagenarian patients; Survival; Valve surgery; Coronary artery bypass graftsurgery.

## 3. Introduction

Population analysis has projected greater life expectancy with a

steady increase in the number of nonagenarians in the UK, who now represent over half a million of the population [1]. This increase is matched by a greater burden of cardiovascular disease [2-4]. Previously published case series have reported acceptable cardiac surgical morbidity and mortality rates and concluded that cardiac surgery can be performed safely in a carefully selected group of patients within this cohort [5-9]. Cardiac surgery in nonagenarian patients is now performed more frequently. Given their advanced age and increased frailty, few studies have reported on the long-term survival of these patients following cardiac surgery.

We conducted a retrospective analysis of 95 patients above 90 years of age who had cardiac surgery performed over the past 20 years in our institution. We compared their survival and post-operative complication rates to those of patients younger than 90 years who also underwent surgery in our institution during the same time period. The aim was to add to our knowledge of cardiac surgery outcomes in this group, which could help guide clinical decision making.

## 4. Patients and Methods

Prospectively collected electronic medical data over 20 years (1998- 2018) were analyzed for all patients aged over 90 years who underwent open heart surgery. Patients receiving transcatheter aortic valve implantation (TAVI) were excluded. Data included demographic information, logistic [10] and additive Euro SCORE [11], type of surgery, length of stay, hospital mortality and major complications. Patients were stratified into three groups according to the type of operation that was performed. Outcomes were compared between the groups and with the overall institutional cardiac surgical population.

Statistical analysis was performed with IBM SPSS 25.0. Survival analysis was done using the Kaplan-Meier test. The log rank test and modified chi squared test were used to establish whether there was any difference in survival time among the study groups. All variables are expressed as mean  $\pm$  standard deviation unless

otherwise stated. Ethical approval was waived by our hospital review board.

**5. Results**

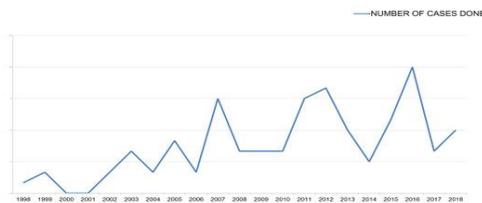
A total of 19,805 patients had cardiac surgery during the study period, of whom 95 were aged between 90 and 99 years (mean 91.2 ±1.58; 42 females; 44%) with the number increasing over the period of the study (Figure i). Table I is a summary of the patient characteristics.

Elective surgery accounted for two thirds of operations, with a majority of the remaining being urgent operations. Only two emergency operations were performed: both were combined valve plus CABG surgery and both patients survived to hospital discharge (Figure ii). The mean additive Euro SCORE was 11.09 ±2.1 and the mean logistic Euro SCORE was 22.8 ±13.7 (mean for the overall cardiac surgical population 9.14).

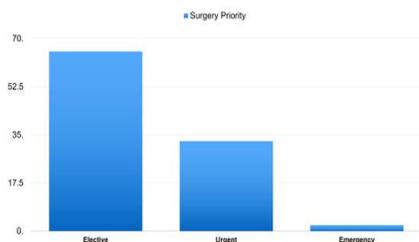
Operations were classified as isolated coronary artery bypass graft surgery (11 patients, 11.5%), isolated valve operations (29 patients, 30.5%) or combined CABG and valveoperation (55 patients, 58%). Aortic valve replacement was the most commonly performed valve surgery(26/29 patients, 89%)

**Table1:** Summary of patient characteristics

	Cardiac patients < 90 years	Nonagenarians
Total Number	19710	95
Mean Age (years)	68.7	91.2
Male	14007 (71%)	53 (55%)
Female	5703 (28%)	42 (44%)
Surgery type: CABG	8374	11
CABG + Valve	3442	55
Valve	7020	29
Other	874	0
Urgency of surgery: Elective	13990	62
Urgent	4682	31
Emergency	1020	2
Salvage	18	0
Mean logistic EuroSCORE	9.14	22.8
Complications:		
Return to theatre for bleeding	5.50%	15%
Post-operative tracheostomy	1.60%	4.20%
Hospital length of stay (Days)	10	17



**Figure 1:** Annual number of nonagenarian open heart operations over past 20 years



**Figure ii:** Surgical priority of nonagenarian open heart operations

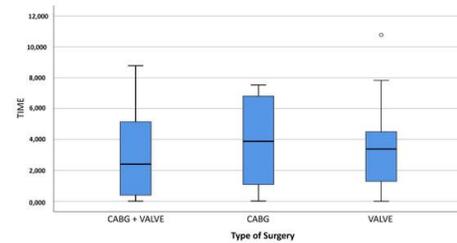
**5.1 Post-Operative Outcome**

There was no intra-operative mortality. Hospital mortality was 8/95 (8.4%). Among these patients, six underwent CABG + valve surgery, 1 aortic valve replacement and 1 CABG. The average survival after discharge was 3.48 years ± 2.92.

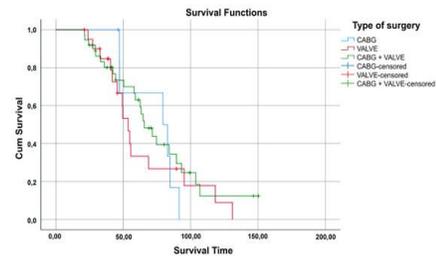
CABG patients survived longer than those who underwent isolated valve surgery, and these in turn had a longer survival than those who had combined CABG and valve surgery (Figure iii), but this did not reach statistical significance.

The three-year survival rate was 32.3%. Further analysis by log rank test and chi square did not find any statistically significant difference in the mean survival time between the three study groups based on the type of surgery performed (Figure iv).

Return to theatre for bleeding was higher among nonagenarians (15% versus 5.5% for the younger patients) as was the rate of post-operative tracheostomy (4.2% versus 1.6%). Table ii shows the post-operative complication rate among nonagenarians. Nonagenarians also had a longer mean hospital stay (17.5 ± 15.3 days) compared to the younger patient group (10.7 ± 8.8 days).



**Figure iii:** Survival time after nonagenarian cardiac surgery by sub-groups



**Figure iv:** Kaplan Meier curve showing survival following nonagenarian cardiac surgery

**Table 2:** Post - Operative complications among nonagenarian patients

Variable	Number (n)	Percentage
Atrial Fibrillation	14	17%
Renal Impairment requiring CVVHD	7	10.20%
Post-Operative bleeding requiring re-exploration	14	15%
Prolonged ventilation with need for tracheostomy	4	4.20%
Post-operative hypotension requiring Inotropes	51	65%

**6. Discussion**

Published studies support the potential benefit of cardiac surgical in selected nonagenarian patients, despite higher mortality rate related to age and co-morbidities. Our hospital mortality rate was

8.4%, 3 times lower than the logistic Euro SCORE and lower than our earlier experience [12]. Other studies reported mortality rates between 7% and 20% [13-15]. The lower mortality rate observed in our study could be explained by better patient selection and improving peri-operative practice over time. All high-risk patients were discussed at a multi disciplinary team meeting consisting of surgeons, cardiologist and anaesthetist. Following this, informed consent process was followed.

Various factors have been associated with the observed higher mortality rate among nonagenarian patients. Bacchetta et al reported a sevenfold increase in mortality among nonagenarians presenting for emergency surgery [7]. We performed emergency operations in only two such patients. Although one had a very high estimated logistic Euro SCORE (76.31%), he was discharged from hospital 21 days following surgery and has survived for more than four years after surgery. Interestingly, unlike previous studies, the majority of deaths occurred among patients scheduled for elective surgery compared to those who underwent urgent surgery. These results are difficult to interpret as urgent surgery represented a small number of patients. It is possible that the elective surgery patients might have been in advanced stages of disease, resulting from either a delay in presentation or a delay in the referral pathway due to reluctance of patients and their physicians to consider surgical treatment. It is important that nonagenarians are appropriately investigated and once diagnosed to have limiting cardiac disease, referred early to specialist centers.

Though not statistically significant, survival was highest among patients who had isolated CABG surgery. Bridges et al found that mortality among nonagenarian CABG patients to be almost comparable to that of younger patients [6]. In our study, mortality rate increased with increasing complexity of surgery and over half of the patients who died in hospital had a double procedure performed. This might be attributed to several factors including a prolonged bypass time and a higher rate of post-operative complications.

The fact that the mortality rate was much lower than predicted confirms that cardiac surgery should continue to be performed in nonagenarians based on symptomatic grounds. Cardiac surgery is an effective treatment for angina and breathlessness and can be expected to substantially improve quality of life. Frailty is directly associated with poor post-operative outcome among elderly patients [16, 17]. As this study was retrospective, we were unable to report on the effect frailty had on the reported patient outcome.

Few studies have reported on the long-term outcome of nonagenarians. It should be appreciated that these patients, in addition to advanced age and frailty, have other comorbidities that might affect life expectancy. We report a low 3-year survival of 32.3%, comparable to but lower than that reported in previous studies [13, 7].

Above the age of 90 years, median survival in the United Kingdom population has been estimated to be 2.9 years to 3.7 years [18]. This study reports a median survival following cardiac surgery of 2.7 years (95% confidence interval 1.4 years to 4 years), slightly lower but comparable to the age matched population. Hence, given the reported low 3-year survival rate, a balanced risk assessment should recognize that in the elderly patient, the main benefit might be symptomatic improvement rather than increased life expectancy.

Among the reported post-operative complications, the higher rate of return to theatre for bleeding among nonagenarians is prominent. In the patients who were returned to theatre for bleeding the documented sources of bleeding included, the aortic cannulation site and from the bone marrow sternotomy site. Bleeding from the aortic cannulation site was controlled by use of pledgeted 3/0 prolene sutures; another intervention was tight hemodynamic control aiming for a mean arterial pressure of 65 -75mmHg to ensure no further bleeds. Bleeding from the sternum bone marrow was controlled by topical hemostasis and use of bone wax. Where there was evidence of coagulopathy from point of care testing (thromboelastography) blood products were transfused. Various factors might have contributed to this including polypharmacy, pre-existing comorbidities or the coagulopathic effects of cardiopulmonary bypass. Studies have reported similar results with increased complication rate in this patient group [12-14]. Early tracheostomy has been associated with reduced mortality after cardiac surgery in patients requiring prolonged mechanical ventilation [19].

The mean duration of mechanical ventilation in patients who required tracheostomy was 185 hours. In our cardiac intensive care practice, there is no specific timing stipulated but approximately 7 days of mechanical ventilation is judged appropriate for tracheostomy. Every effort should be made to reduce the rate of post-operative complications, which are often poorly tolerated by the elderly.

Generally, elderly patients tend to have a longer hospital stay due to increased post-operative complications but social factors also play a part [13, 15, 20]. The retrospective nature of this study is a limitation which precluded us from evaluating quality of life after surgery, and we are unable to report on quality-adjusted life expectancy.

## 7. Conclusions

This study represents the largest single-center experience in the UK investigating the outcome of nonagenarian patients undergoing cardiac surgery.

Mortality rate was lower than predicted and supports continuing cardiac surgery in nonagenarians, while recognizing that they have a higher risk of major complications, prolonged hospital stay and increased use of resources. These patients also have a low long-term survival rate.

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