

# Clinical Outcome After Triple-Valve Operations in the Modern Era: Are Elderly Patients at Increased Surgical Risk?

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**Background.** Despite modern advances in surgical care, triple-valve surgery (TVS) remains a challenge and carries a mortality of 10% to 20%. No validated risk score is available for TVS, and the effect of advanced age is unknown. This study examined our results in the modern era with the aim of identifying perioperative predictors of adverse outcomes.

**Methods.** Between 1997 and 2013, 131 patients (mean age,  $67.2 \pm 13.4$  years) underwent TVS at our institution. Sixty-eight patients (51.9%) were aged 70 years and older. The most common etiology for aortic and mitral disease was degenerative (77.1%), rheumatic (10%), and endocarditis or prosthetic-related, or both, in the rest. Tricuspid valve disease was functional in 96%. New York Heart Association functional class III/IV was present in 69.4%, and 24% had had previous cardiac operations. One or more concomitant cardiac procedures were performed in 77 patients (58.8%), including coronary revascularization in 54. All aortic procedures were replacements, 14 patients required a prosthetic root conduit and 7 thoracic aorta replacement. Mitral replacements were used in 55%, repairs in 45%, and 96.2% of tricuspid procedures were repairs. Univariate and multivariate analyses were used to determine predictors of adverse outcomes.

**Results.** The 30-day and hospital mortality was 10.6% ( $n = 14$ ). Major complications occurred in 70 (53.4%). Univariate analysis identified New York Heart Association functional class III/IV ( $p = 0.04$ ), preoperative renal failure requiring dialysis ( $p = 0.04$ ), urgent operation ( $p = 0.04$ ), intraaortic balloon pump placement ( $p = 0.02$ ), and postoperative low cardiac output ( $p < 0.0001$ ) as predictors for early death. Proximal aortic operations, urgent operation, and New York Heart Association class IV correlated with increased early mortality ( $p < 0.04$ ) in patients aged 70 and older in addition to their decreased overall survival and decreased likelihood of discharge to home. Overall actuarial survival at 1, 5, and 10 years was 84.5%, 75%, and 45%, respectively.

**Conclusions.** TVS remains a surgical challenge in the modern era. Despite a trend of increasing age and surgical risk, the early mortality rate and long-term survival remain respectable. Advanced age is associated with increased perioperative risk, but age per se should not be a contraindication for TVS.

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Despite modern advances in surgical care, concomitant aortic, mitral, and tricuspid valve operations remain challenging and morbid [1, 2]. Increased age, need for reoperation, and associated cardiac procedures are a few of the potential factors associated with the high surgical risk. There are limited data evaluating modern perioperative risk after triple-valve surgery (TVS). Furthermore, surgical predictive scores used for TVS are not validated at the present [3]. The aim of this study was to determine modern outcomes after TVS and to determine basic risk-predictive perioperative variables for adverse outcome.

## Patients and Methods

This retrospective study was approved by the Institutional Review Board of the University of Louisville and its affiliated hospitals.

### Patient Inclusion

Between March 1997 and February 2013, 140 patients underwent TVS at the University of Louisville affiliated hospitals, Louisville, Kentucky. TVS was defined as repair or replacement of the aortic, mitral, and tricuspid valves ( $n = 131$ ). Pulmonary valve operations were excluded as a third valve for TVS ( $n = 4$ ) but included only if done as a fourth valve and counted as an associated cardiac procedure. Patients with insufficient clinical data were not included ( $n = 5$ ), and none of those had an early death.

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**Abbreviations and Acronyms**

CABG	= coronary artery bypass graft
CPB	= cardiopulmonary bypass
EF	= ejection fraction
EuroSCORE	= European System for Cardiac Operative Risk Evaluation
HR	= hazard ratio
ICU	= intensive care unit
NYHA	= New York Heart Association
PAP	= pulmonary artery pressure
SD	= standard deviation
TIA	= transient ischemic attack
TVS	= triple-valve surgery

A retrospective office and hospital record review was performed for patients before 2003, and The Society of Thoracic Surgeons institutional database used after 2003 in addition to clinical records. The mean follow-up for survival was  $6.4 \pm 0.3$  years and was available in 100% of patients. Along with office notes, readmission data, and referring physician notes, the Social Security Death Index was accessed to determine the alive/dead status of patients. The data were reported according to "Guidelines for Reporting Mortality and Morbidity After Cardiac Valve Interventions" by Akins and colleagues [4].

*Patient Characteristics*

Patient demographics and comorbidities are delineated in Table 1. Mean age was  $67.2 \pm 13.4$  years, and 68 patients were aged 70 and older (51.9%). Etiology of valve disease with severity and indications for operation are summarized in Table 2. The most common etiology was degenerative in 101 (77.1%), followed by rheumatic in 13 (10%), prosthetic valve dysfunction in 12 (9.1%), and infective endocarditis in 5 (3.8%). Tricuspid valve etiology was functional in 120 (91%). Urgent or emergent operations were performed in 35 patients (26.7%).

*Surgical Technique*

All surgical procedures were performed through a median sternotomy. Cardiopulmonary bypass with cold blood cardioplegic arrest (antegrade and retrograde infusions) and permissive hypothermia (32°C) was used unless an open aortic arch anastomosis was required, in which hypothermic circulatory arrest was used. Mean cardiopulmonary bypass time was  $171.1 \pm 41.3$  minutes (range, 100 to 401 minutes), and aortic cross-clamp time was  $131.7 \pm 28.0$  minutes (range, 70 to 223 minutes). Hypothermic circulatory arrest was used in 4 patients (mean time, 18 minutes). Mechanical or biologic prosthesis, or both, were implanted according to age, comorbidities, and surgeon or patient preferences. There

Table 1. Demographic Data and Risk Factors

Variable	Total Cohort <sup>a</sup> (n = 131)	Age < 70 <sup>a</sup> (n = 63)	Age ≥ 70 <sup>a</sup> (n = 68)	p Value
Age, y	67.2 ± 13.4	56.3 ± 11.3	77.2 ± 4.3	<0.0001
Female gender	72 (54.9)	32 (50.7)	40 (58.8)	0.35
Body mass index, kg/m <sup>2</sup>	26.7 ± 5.5	27.4 ± 5.9	26.27 ± 5.1	0.28
Hypertension	100 (76.9)	44 (69.8)	56 (83.5)	0.06
Diabetes mellitus	27 (20.7)	14 (22.2)	13 (19.4)	0.69
Peripheral vascular disease	22 (16.9)	13 (20.6)	9 (13.4)	0.27
Cerebrovascular disease	23 (17.6)	7 (11.1)	16 (23.8)	0.05
Chronic lung disease	41 (31.5)	25 (39.6)	16 (23.8)	0.07
Myocardial infarction	33 (25.5)	13 (20.9)	20 (29.8)	0.24
Atrial arrhythmia	56 (42.7)	29 (46.0)	27 (39.7)	0.46
Pre-op hemodialysis	9 (8.4)	8 (15.0)	1 (1.8)	0.01
Creatinine >1.4 mg/dL	26 (26.5)	12 (27.9)	14 (25.4)	0.78
Dyslipidemia	66 (50.7)	28 (44.4)	38 (56.7)	0.16
Status urgent/emergent	35 (26.7)	24 (38.1)	11 (16.1)	0.004
NYHA functional class				
I, II	40 (30.5)	17 (26.9)	23 (33.8)	0.73
III	58 (44.2)	28 (44.4)	30 (44.1)	
IV	33 (25.1)	18 (28.5)	15 (22.0)	
Ejection fraction	0.482 ± 0.138	0.441 ± 0.153	0.521 ± 0.110	0.0008
EuroSCORE II	10.4 ± 9.8	9.4 ± 7.7	11.2 ± 11.3	0.30
Mean PAP, mm Hg	30.2 ± 10.6	31.4 ± 11.5	29.2 ± 9.8	0.24

<sup>a</sup> Data are presented as mean ± standard deviation or number (%)

EuroSCORE = European System for Cardiac Operative Risk Evaluation; pressure.

NYHA = New York Heart Association;

PAP = pulmonary artery

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