

# Isolated Mitral Valve Surgery: The Society of Thoracic Surgeons Adult Cardiac Surgery Database Analysis

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**Background.** Data from The Society of Thoracic Surgeons Adult Cardiac Surgery Database were analyzed to identify trends in patient characteristics and outcomes of mitral valve operations in North America.

**Methods.** All patients with isolated primary mitral valve operations with or without tricuspid valve repair, surgical atrial fibrillation ablation, or atrial septal defect closure performed July 2011 to September 2016 were identified. A subgroup analysis assessed patients with degenerative leaflet prolapse (DLP).

**Results.** Isolated primary mitral valve operations were performed on 87,214 patients at 1,125 centers, increasing by 24% between 2011 (n = 14,442) and 2016 (n = 17,907). The most common etiology was DLP (60.7%); 4.3% had functional mitral regurgitation. Preoperatively, 47.3% of patients had an ejection fraction less than 60% and 34.2% had atrial fibrillation. Overall mitral valve repair rate was 65.6%, declining from 67.1% (2011) to 63.2% (2016;  $p < 0.0001$ ). Repair rates were related to etiology (DLP,

82.5%; rheumatic, 17.5%). Of the 29,970 mitral valve replacements, 16.2% were preceded by an attempted repair. Repair techniques included prosthetic annuloplasty (94.3%), leaflet resection (46.5%), and artificial cord implantation (22.7%). Bioprosthetic valves were implanted with increasing frequency (2011, 65.4%; 2016, 75.8%;  $p < 0.0001$ ). Less-invasive operations were performed in 23.0% and concomitant tricuspid valve repair in 15.7%. Unadjusted operative mortality was 3.7% (replacements) and 1.1% (repairs).

**Conclusions.** Patients undergoing primary isolated mitral valve operations commonly have ventricular dysfunction, atrial fibrillation, and heart failure. Although contemporary outcomes are excellent, earlier guideline-directed referral and increased frequency and quality of repair may further improve results of mitral valve operations.

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Mitral valve (MV) surgery alleviates symptoms of heart failure, prevents or reverses ventricular remodeling, and decreases mortality in patients with severe MV disease. Contemporary trends in the therapy of patients with MV disease include an enhanced understanding of the benefits of timely referral for operation [1, 2], acknowledgment of the superiority of repair compared with replacement for degenerative mitral regurgitation [3, 4], and

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**Abbreviations and Acronyms**

ACSD	= Adult Cardiac Surgery Database
AF	= atrial fibrillation
AV	= aortic valve
DLP	= degenerative leaflet prolapse
IQR	= interquartile range
LVEF	= left ventricular ejection fraction
MR	= mitral regurgitation
MV	= mitral valve
NYHA	= New York Heart Association
O/E	= observed to expected
PROM	= predictive risk of mortality
sPAP	= systolic pulmonary artery pressure
STS	= The Society of Thoracic Surgeons

improved operative outcomes [3]. The Society of Thoracic Surgeons (STS) Adult Cardiac Surgery Database (ACSD) data elements were updated in 2011 to provide a more complete and accurate assessment of MV disease etiology as well as operative therapy, and outcomes. The STS ACSD was examined to document contemporary patient characteristics, operative approaches, and clinical outcomes of patients undergoing MV operations in North America.

**Material and Methods**

The STS ACSD is a repository for more than 6.1 million surgical records, encompassing voluntarily reported data from more than 90% of all adult cardiac surgery centers in the United States [5, 6]. Research performed at the Duke Clinical Research Institute on the STS database was approved by the Duke University Institutional Review Board and was granted a waiver of informed consent and Health Information Portability and Accountability Act authorization. Principal investigators at participating institutions are responsible for reviewing their data collection efforts with their sites' Institutional Review Boards to ensure that patient privacy and confidentiality is protected.

*Patient Population*

Patients who underwent primary isolated MV operations between July 1, 2011, and September 30, 2016, were identified in the STS ACSD (v.2.73 and 2.81). Data on the number and type of procedures from 2011 (6 months of available data) and 2016 (9 months of available data) were normalized to 12 months for volume trend analyses. Isolated MV operations were defined as those without concomitant coronary artery bypass graft surgery or aortic valve (AV) procedure and with or without tricuspid valve repair, surgical ablation of atrial fibrillation (AF), or atrial septal defect closure. Patients with a history of prior cardiac procedure, emergent or emergent/salvage status, shock, or active infective endocarditis were excluded.

From the full cohort of patients undergoing isolated primary MV operations, a hierarchical classification system was used to identify the etiologies underlying the associated MV disease [7]. Etiologies were not mutually exclusive. Because at least one and as many as three

etiologies could be selected in the data classification forms, etiology was assigned sequentially, beginning with treated endocarditis, followed by rheumatic disease, uncommon diseases (tumor, hypertrophic obstructive cardiomyopathy, trauma, and congenital), ischemic disease, nonischemic cardiomyopathy, degenerative leaflet prolapse (DLP), pure annular dilation, and other/unknown.

Patients with DLP, defined as those having Carpentier class II dysfunction and/or leaflet prolapse (anterior, posterior, and/or bileaflet) and/or elongated or ruptured chords, and excluding patients with endocarditis, stenosis, rheumatic disease, tumor, hypertrophic obstructive cardiomyopathy, trauma, congenital disease, and ischemic disease were separately analyzed for outcomes and repair rates.

*Definitions*

Active infective endocarditis, congestive heart failure, prior heart failure, and mitral regurgitation (MR) were previously defined [8]. Mitral regurgitation was reported as none, trivial/trace, mild, moderate, severe, or not documented, based on the American Society of Echocardiography guidelines [9]. All MR grades were site-determined. Mitral regurgitation scores of "none" and "trivial/trace" were combined into a single variable (none/trace) for the purposes of this analysis. Less invasive MV operations were defined as those done through a limited minithoracotomy, port access, and right thoracotomy, as well as those identified as minimally invasive or robotic technology assisted. The STS predictive risk of operative mortality (PROM) score was calculated based on the published STS 2007 risk model for isolated valve surgery [10].

Indications for MV surgery were defined [2, 11] as class I symptomatic (severe MR with symptoms), class I asymptomatic (severe MR and left ventricular ejection fraction [LVEF] of 30% to 60% and/or a left ventricular end-systolic dimension of 40 mm or more, with no symptoms), class IIa asymptomatic without triggers (severe MR and LVEF greater than 60% and left ventricular end-systolic dimension less than 40 mm), and class IIa asymptomatic with triggers (severe MR and LVEF greater than 60% and left ventricular end-systolic dimension less than 40 mm and either AF and/or pulmonary artery systolic pressure [sPAP] greater than 50 mm Hg).

*Statistical Analysis*

Statistical analyses (SAS statistical software v.9.4; SAS Institute, Cary, NC) included  $\chi^2$  tests for categorical variables, Cochran-Armitage trend tests for tests of trend, and Wilcoxon tests for continuous variables. Because the DLP group was a subgroup of the overall cohort, applicable mean comparisons were done between the DLP group and the portion of the overall cohort not containing the DLP patients. All other mean comparisons were calculated between the repair and replacement subsets of the respective parent grouping (overall or DLP).

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