



A Nomogram For Predicting Prolonged Length Of Stay After Valve Surgery Via Mini-thoracotomy

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Objective

Although shortening the post-operative length of stay (LOS) has clinical and financial advantages¹, no univocal method exists to systematically reduce LOS after valve surgery. It is generally acknowledged that minimal access incisions are associated with reduced postoperative length of stay (LOS) and previous evidence showed that mini-thoracotomy positively impacts on postoperative LOS when compared to sternotomy^{2,3}. Moreover, the recent introduction of the enhanced recovery after surgery protocol in cardiac surgery (ERAS®) has significantly impacted on reducing LOS after surgery³. In this context, defining potential factors affecting LOS would be beneficial in improving pre and postoperative care, reducing LOS and thus optimizing patient flow. We therefore aimed to identify preoperative predictors for prolonged LOS and to create a risk score to identify patients at higher risk of prolonged LOS after valve surgery conducted via mini thoracotomy.

Methods

This is a retrospective single-center analysis of 189 consecutive patients undergoing aortic, mitral or tricuspid valve surgery at our institution between October 2018 and May 2021. The surgeries were all conducted via a mini-thoracotomy. 119 patients underwent isolated mitral valve (MV) surgery (83 repairs and 36 replacements), while 50 patients underwent isolated aortic valve (AV) replacement, and 5 patients underwent isolated tricuspid (TV) surgery (4 repairs and 1 replacement). 15 patients underwent a combined double valve procedure (1 AV and MV repair, 3 AV replacement and MV repair, 5 AV and MV replacement, 4 MV and TV repair and 2 MV replacement and TV repair). The patients were divided in two groups according to the median postoperative LOS: 125 patients were included in the standard LOS group (≤ 7 days) and 64 in the prolonged LOS group (> 7 days). Most patients were discharged home (104 patients - 56.8%), while 78 patients (41.3%) were discharged at a rehabilitation center. For 7 patients the discharge location was not recorded. The most common preoperative characteristics were collected and analyzed to predict prolonged LOS.

Statistical Analysis
All study group comparisons were unpaired. Categorical variables were compared using either Pearson or Fisher exact tests, and continuous variables were compared using the Student t-test for normally distributed data or the Wilcoxon rank sum test for non-normally distributed data where appropriate. Univariable and multivariable logistic regression analyses were used to screen the predictors and develop a risk nomogram. Backward stepwise selection was used to obtain the adjusted models. Variable importance was calculated for each variable.

Table 1. Preoperative Characteristics

Characteristic	Overall, n = 189	Standard LOS, n = 125	Prolonged LOS, n = 64	p-value
Age (years)	63 (13.3)	61 (12.4)	68 (14.0)	<0.001
Female Gender	71 (37.6%)	42 (33.6%)	29 (45.3%)	0.116
Active Smoker	20 (10.6%)	12 (9.6%)	8 (12.5%)	0.540
Hypertension	62 (32.8%)	40 (32.0%)	22 (34.4%)	0.742
Dyslipidemia	45 (23.8%)	30 (24.0%)	15 (23.4%)	0.932
Diabetes	8 (4.2%)	7 (5.6%)	1 (1.6%)	0.270
PVD	30 (15.9%)	17 (13.6%)	13 (20.3%)	0.232
CKD	38 (20.1%)	18 (14.4%)	20 (31.2%)	0.006
COPD	32 (16.9%)	17 (13.6%)	15 (23.4%)	0.088
Reoperation	23 (12.2%)	9 (7.2%)	14 (21.9%)	0.003
Pre-operative LVEF (%)	60 (6.7)	60 (6.1)	59 (7.8)	0.331
BMI (kg/m ²)	25 (4.2)	24 (4.3)	25 (4.0)	0.568
NYHA Class > III	49 (25.9%)	23 (18.4%)	26 (40.6%)	<0.001
Reduced LVEF (< 50%)	24 (12.7%)	10 (8.0%)	14 (21.9%)	0.007

Data are reported as mean and SD and as count and percentages. Definitions: PVD: Peripheral Vascular Disease, CKD: Chronic Kidney Disease, COPD: Chronic Pulmonary Obstructive Disease, NYHA: New York Heart Association, BMI: Body Mass Index. LVEF: Left Ventricular Ejection Fraction.

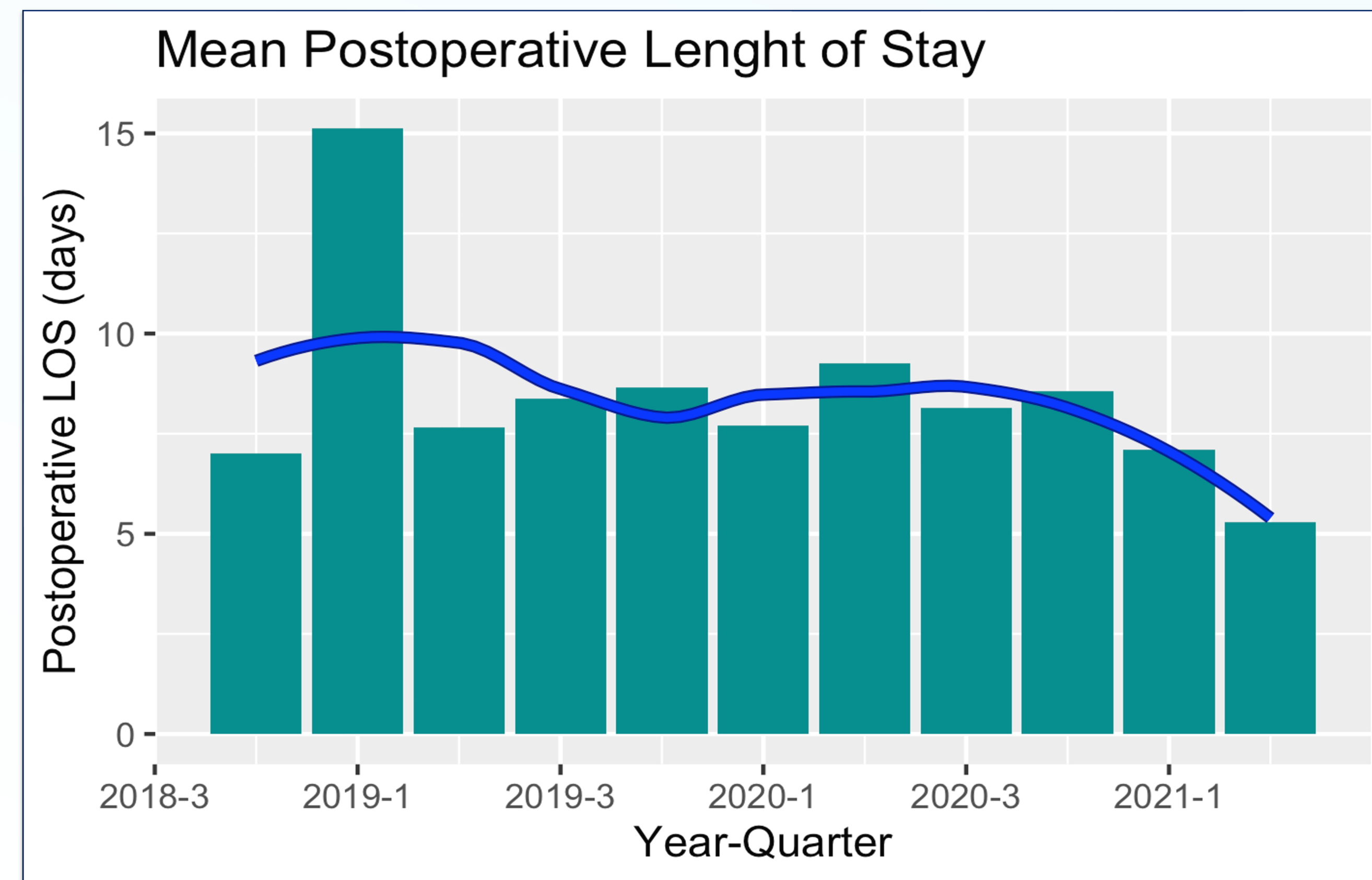


Figure 1. Quarterly Mean Postoperative Length of Stay

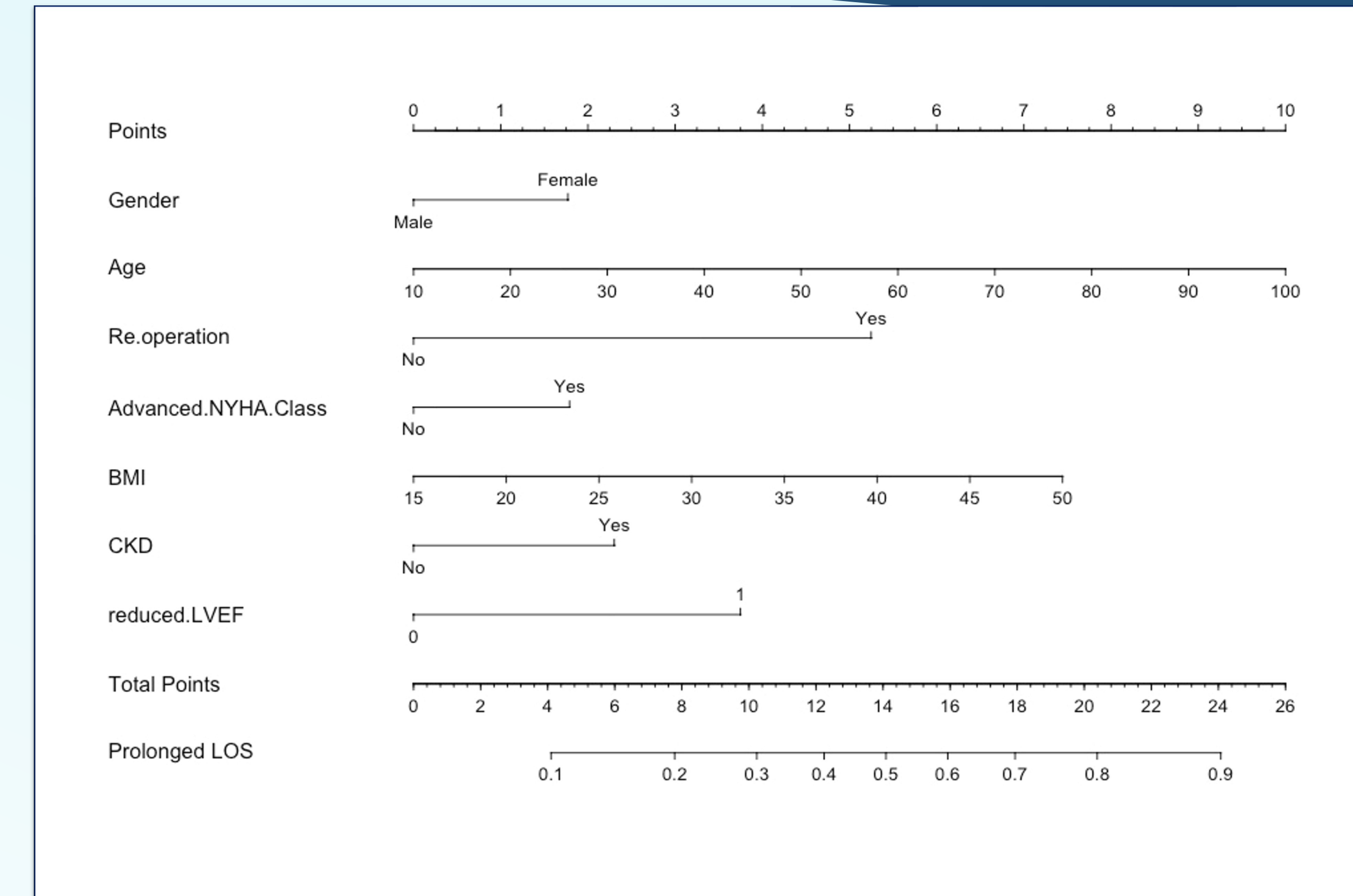


Figure 2. Predicting nomogram for prolonged LOS

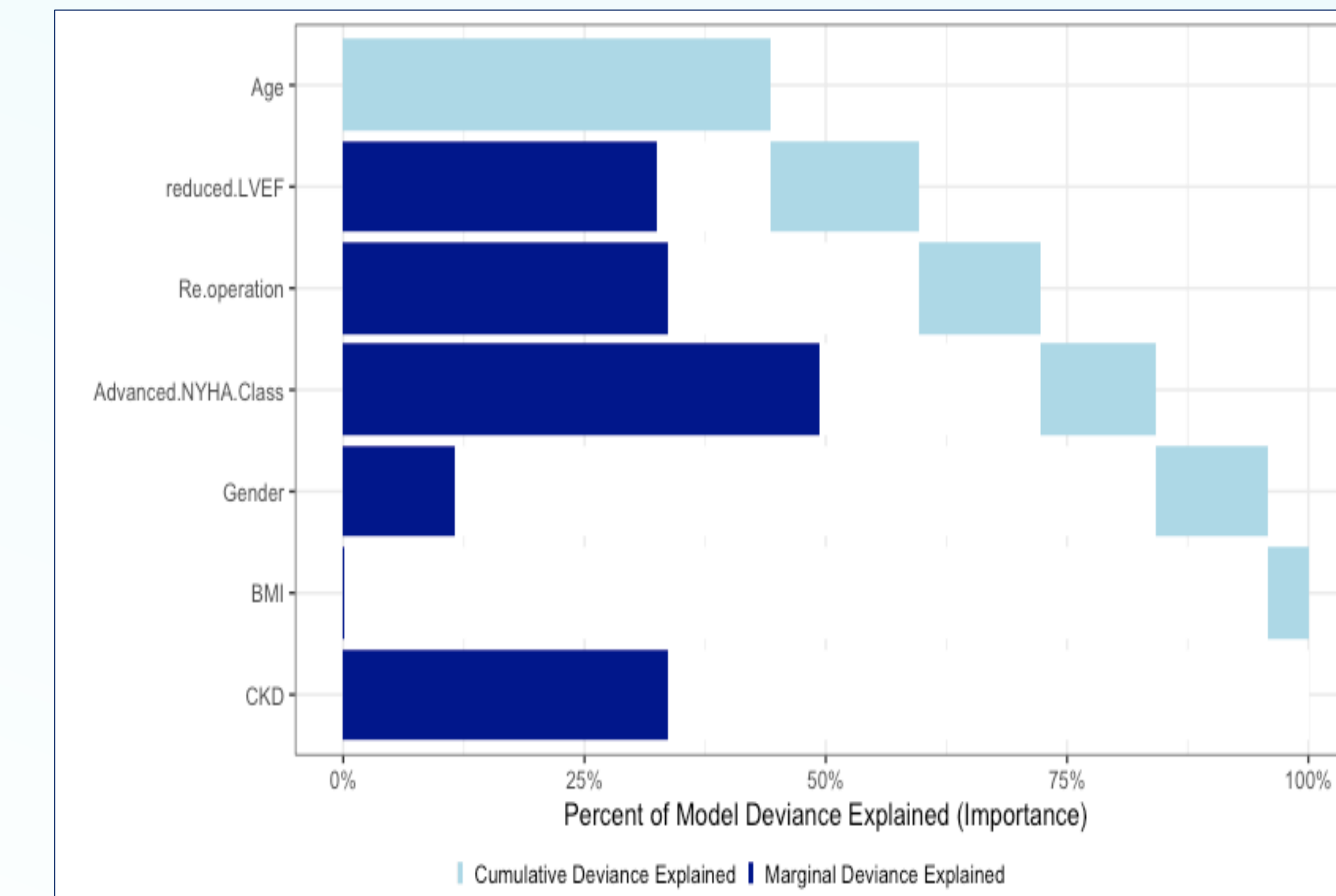


Figure 3. Variable's importance for the predictors included in the final model

Results

Table 1 shows the preoperative characteristics of the patients. The mean postoperative LOS was 9.13 days (median: 7 days) with a trend towards a shorter LOS in the last period of observation(Fig. 1). The patients included in the prolonged LOS group were older, more frequently in NYHA Class III or IV, with worst left ventricular function and with a higher incidence of reoperation and chronic kidney disease (CKD). A prognostic nomogram based on these five variables (plus gender and BMI) was developed (Fig.2) with an accuracy of 0.69 (95% CI: 0.60 - 0.78).

After backward variables selection, the multivariable logistic regression model showed that the most significant preoperative factors predicting prolonged LOS were Age (OR 1.03, 95% CI 1.01-1.06, $p = 0.02$) and redo surgery (OR 3.33, 95% CI 1.29-8.9, $p = 0.01$). The model was then adjusted for the presence of at least one postoperative complications. As expected, the presence of complication significantly impacted prolonged LOS (OR 5.7, 95% CI 2.92 – 11.5, $p < 0.01$), but Age (OR 1.03, 95% CI 1.003-1.06, $p = 0.03$), and reduced LVEF (OR 2.8, 95% CI 1.07-7.6, $p = 0.03$) were confirmed independent predictors of prolonged LOS after backward selection.

Figure 3 describes the relative variable's importance for the predictors included in the nomogram.

Limitations:

- Retrospective, single center
- Potential bias due to rehabilitation discharges
- Postoperative LOS is influenced by complications
- No implementation of ERAS protocol in our series

Conclusion

A nomogram for predicting on LOS after minimally invasive surgery was developed. The most critical factors impacting on this outcome are represented by age and redo surgery. When adjusted for postoperative complications age, and reduced LVEF remained independent predictors of LOS. Further larger multicenter analyses are required to better define a prognostic model.

References

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