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Article

Early Mortality Following Mitral Valve Surgery in Patients With Rheumatic Heart Disease and Severe Pulmonary Hypertension

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Abstract

Background: Rheumatic heart disease (RHD) remains highly prevalent in Yemen, often presenting with advanced mitral valve lesions and pulmonary hypertension (PH). However, prospective data on early postoperative outcomes, including 3-month mortality, are limited. Therefore, this study aimed to evaluate the association between preoperative PH severity and 3-month outcomes following mitral valve surgery for RHD in Yemen. **Methods**: A prospective observational study was performed on 134 adult patients with RHD who were undergoing mitral valve surgery at the Cardiovascular and Kidney Transplantation Center, Taiz, Yemen (January 2022–August 2024). Patients were stratified according to preoperative systolic pulmonary artery pressure (sPAP) into Group I (<60 mmHg) and Group II (≥60 mmHg). All-cause 3-month mortality, readmissions, and major postoperative complications were recorded. **Results**: The 30-day mortality was low and did not differ significantly between groups (3.9% vs. 3.5%; $p = 0.907$). The overall 3-month all-cause mortality rate was 10.4%, with no significant difference in mortality within the two groups (12.3% vs. 9.1%; $p = 0.551$). The early complication rates and hospital readmissions were comparable between groups. **Conclusions**: Early mitral valve surgery before the development of severe PH and right ventricular dysfunction was shown to improve survival outcomes. Surgery is safe and feasible for RHD patients with severe PH, with low early mortality and an 89.6% 3-month survival rate.

Keywords: rheumatic heart disease; mitral valve surgery; pulmonary hypertension; 3-month outcomes; Yemen

1. Introduction

Rheumatic heart disease (RHD) remains a leading cause of cardiovascular mortality in low- and middle-income countries, particularly in regions such as Yemen, where patients often present late with advanced valvular lesions due to delayed diagnosis and limited access to specialized cardiac care [1,2]. Among these lesions, mitral valve involvement is the most common, and is frequently associated with pulmonary hypertension (PH) that significantly increases surgical risk [3–6].

Preoperative PH has been strongly linked to increased postoperative mortality, reflecting chronic pressure overload on the pulmonary circulation and progressive left-sided heart dysfunction. Multiple studies from high-income countries have demonstrated that PH adversely affects early survival following mitral valve surgery, particularly by increasing perioperative hemodynamic instability, right heart failure, and impaired oxygenation. However, these studies primarily involve populations with degenerative or ischemic mitral disease and benefit from advanced perioperative support [7–13].

In Yemen, the burden of RHD is disproportionately high, with many patients undergoing mitral valve surgery in late disease stages, often with uncorrected PH and limited access to advanced perioperative care. No published data evaluate the impact of preoperative PH on early outcomes in this resource-limited setting. To address this gap, we conducted the first prospective study to evaluate the association between preoperative PH and 3-month outcomes following mitral valve surgery for RHD, providing important local evidence to guide surgical decision-making in similar low-resource environments.

2. Methods

This prospective observational study included 134 consecutive adult patients diagnosed with RHD who underwent mitral valve surgery at the Cardiovascular and Kidney Transplantation Center (CVKTC), Taiz, Yemen, between January 2022 and August 2024.

2.1 Surgical Procedure

All mitral valve surgeries were performed via median sternotomy under general anesthesia with cardiopulmonary bypass (CPB). Myocardial protection was achieved using cold blood cardioplegia. All procedures were performed by the single dedicated cardiac surgery team at CVKTC. The

Table 1. Preoperative characteristics of patients with rheumatic valves disease and PH (n = 134).

Variable	Group I (n = 77)	Group II (n = 57)	Total (n = 134)	*p* value
Age, yr, median (IQR)	40 (32–50)	36 (25–46)	38.5 (30–48.3)	0.100
Female Sex, n (%)	55 (66.3)	28 (33.7)	83 (100)	0.009
Male Sex, n (%)	22 (43.1)	29 (56.9)	51 (100)	
BMI, kg/m^2, median (IQR)	21.4 (18.3–26.5)	19 (16.7–23.7)	20.9 (17.8–25.4)	0.016
CHF, n (%)	3 (3.9)	3 (5.3)	6 (4.5)	0.699
HT, n (%)	5 (6.5)	3 (5.3)	8 (6.0)	1.000
Pre-operative CVA, n (%)	19 (24.7)	2 (3.5)	21 (15.7)	0.001
Smoking, n (%)	16 (20.8)	9 (15.8)	25 (18.7)	0.464
NYHA II	1 (1.3)	1 (1.8)	2 (1.5)	
NYHA III	39 (50.6)	30 (52.6)	69 (51.5)	0.946
NYHA IV	37 (48.1)	26 (45.6)	63 (47)	
Pre-operative AF, n (%)	35 (45.5)	25 (43.9)	60 (44.8)	0.854
EuroSCORE II, median (IQR)	1.50 (1.12–2.30)	2.22 (1.63–3.30)	1.71 (1.27–2.62)	<0.001
LVEF, median (IQR)	58 (49–64)	58 (50–66)	58 (50–64)	0.615
MS, n (%)	28 (36.4)	22 (38.6)	50 (37.3)	0.792
MR, n (%)	15 (19.5)	8 (14)	23 (17.2)	0.409
Mixed Mitral Lesion, n (%)	34 (44.2)	27 (47.4)	61 (45.5)	0.712
Concomitant TR, n (%)	20 (26)	41 (71.9)	61 (45.5)	<0.001

PH, pulmonary hypertension; LVEF, left ventricular ejection fraction; AF, atrial fibrillation; BMI, body mass index; CHF, congestive heart failure; CVA, cerebrovascular accident; EuroSCORE II, european system for cardiac operative risk evaluation II; HT, hypertension; IQR, interquartile range; MR, mitral regurgitation; MS, mitral stenosis; NYHA, New York Heart Association functional class; TR, tricuspid regurgitation.

surgical approach and any concomitant procedures, such as tricuspid valve repair or aortic valve replacement, were determined intraoperatively based on the severity and complexity of the valvular pathology. This standardized approach minimized variability and ensured comparable perioperative outcomes across patients.

2.2 Preoperative Assessment

All patients underwent a detailed medical history, physical examination, and transthoracic echocardiography (TTE). Systolic pulmonary artery pressure (sPAP) was estimated non-invasively using Doppler-derived tricuspid regurgitant jet velocity, in accordance with standard echocardiographic guidelines. Based on sPAP, patients were stratified into two groups: Group I (non-severe PH): sPAP <60 mmHg, and Group II (severe PH): sPAP ≥ 60 mmHg. The cutoff value was selected according to the 2022 European Society of Cardiology (ESC)/European Respiratory Society (ERS) Guidelines for the diagnosis and treatment of pulmonary hypertension and previous studies addressing surgical outcomes in RHD patients [14]. All patients received standard medical therapy for RHD, but none received PH-specific treatments prior to surgery.

2.3 Exclusion Criteria

Patients were excluded if they had isolated aortic valve disease, degenerative or ischemic mitral regurgitation, primary PH, chronic obstructive pulmonary disease (COPD), renal dysfunction (serum creatinine ≥ 2 mg/dL), or hepatic impairment (total serum bilirubin ≥ 3 mg/dL).

2.4 Data Collection

Preoperative variables included age, sex, body mass index (BMI), New York Heart Association (NYHA) functional class, atrial fibrillation (AF), and left ventricular ejection fraction (LVEF). Intraoperative variables included type of mitral valve procedure, concomitant valve surgeries (e.g., tricuspid valve repair or aortic valve replacement), left atrial appendage (LAA) management (plication or thrombectomy), CPB time, and aortic cross-clamp (ACC) time.

2.5 Postoperative Follow-up and Outcomes

After their index hospital stay, Patients were followed at 3-month postoperatively, either through scheduled outpatient visits or telephone follow-up.

2.6 Primary Outcomes

30-day mortality: death from any cause within 30 days of surgery and 3-month mortality: death from any cause within 90 days of surgery.

2.7 Secondary Outcomes

Hospital readmission within 3 months and the cause (cardiac or non-cardiac). Major postoperative complications during the initial hospitalization or within 3

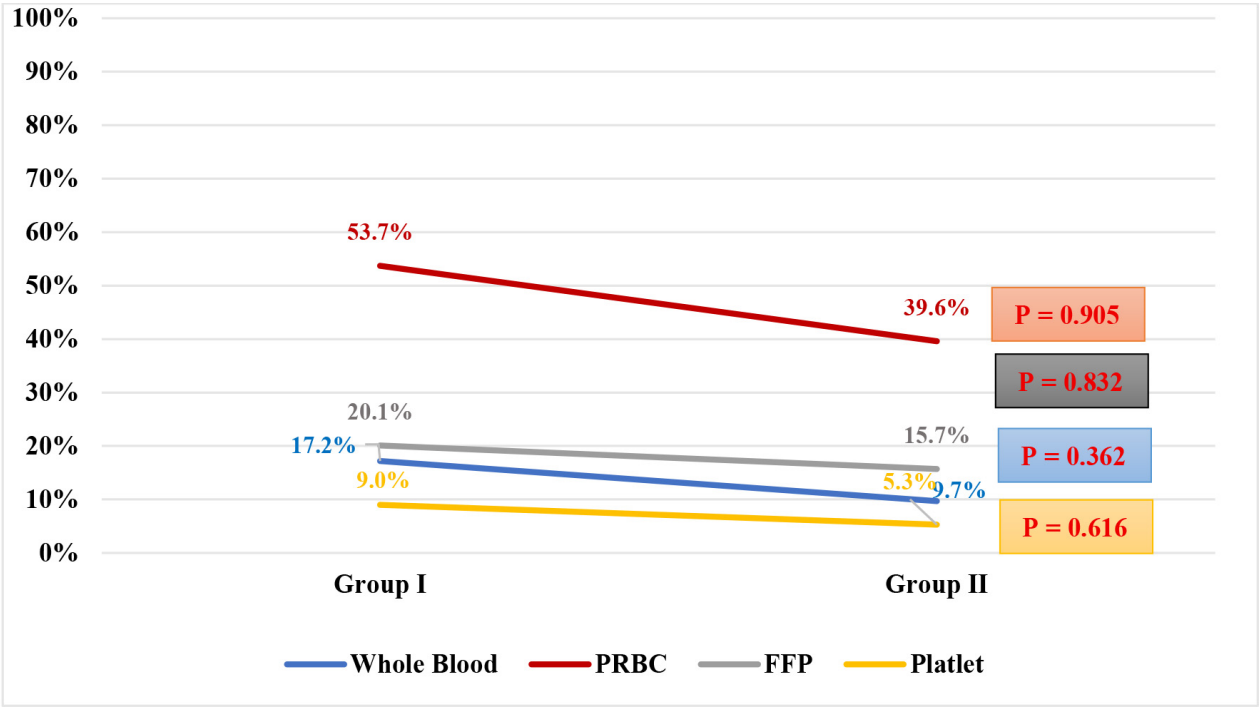

Fig. 1. Blood products utilization among the study population, n = 134. FFP, fresh frozen plasma; PRBC, packed red blood cell.

months, including: re-operation, pleural effusion requiring drainage, postoperative cerebrovascular accident (CVA), intensive care unit (ICU) stay, and length of hospital stay (LOS).

2.8 Statistical Analysis

Statistical analysis was performed using SPSS software (version 24, IBM Corp., Armonk, NY, USA). Continuous variables were reported as median and interquartile range (IQR) and compared using the Mann–Whitney U test. Categorical variables were expressed as frequencies and percentages and analyzed using the Chi-square test or Fisher's exact test, as appropriate. A p-value of <0.05 was considered statistically significant.

3. Results

The preoperative clinical characteristics of the 134 patients were summarized in Table 1. Patients with severe PH tended to be slightly younger, although the difference in median age was statistically not significant (40 vs. 36 years, $p = 0.100$). Female predominance was observed in both groups, with significantly higher proportion in Group I (66.3% vs. 33.7%, $p = 0.009$). Patients in Group II exhibited significantly lower BMI than Group I (median 19 vs. 21.4 kg/m^2, $p = 0.016$), suggesting a potential association between severe PH and nutritional status or chronic disease burden. Regarding functional status, the majority of patients in both groups were classified as NYHA class III or IV, reflecting advanced heart failure symptoms in this population, with no significant difference between groups ($p = 0.946$). EuroSCORE II was significantly higher in Group II (median 2.22 vs. 1.50, $p < 0.001$), consistent with the higher surgical risk associated with severe PH. The types of mitral valve lesions (stenosis, regurgitation, or mixed) were similarly distributed between the groups, but concomitant tricuspid regurgitation (TR) was significantly more common in Group II (71.9% vs. 26.0%, $p < 0.001$), aligning with the pathophysiological consequences of longstanding PH.

Intraoperatively, tricuspid valve repair (TVR) was significantly more frequent in Group II (57.9% vs. 20.8%, $p < 0.001$), further supporting the higher burden of right heart involvement in these patients (Table 2). CPB time and ACC time were both significantly longer in Group II (CPB: 120 vs. 95 min, $p = 0.001$; ACC: 89 vs. 71 min, $p = 0.009$), reflecting greater surgical complexity caused by right heart strain and associated procedures like TVR.

A substantial proportion of patients in both groups required perioperative blood transfusion, reflecting the invasive nature of mitral valve surgery and the hemodynamic challenges inherent to advanced RHD. Packed red blood cells (PRBCs) were the most frequently transfused component, administered to 53.7% of Group I patients and 39.6% of Group II patients, followed by fresh frozen plasma (FFP) (20.1% vs. 15.7%), whole blood (17.2% vs. 9.7%), and platelet concentrates (9.0% vs. 5.3%). None of these differences reached statistical significance (Fig. 1). These findings highlight the importance of meticulous perioperative hemostatic management and the implementation of blood conservation strategies, particularly in resource-limited settings with shortage of blood and blood products supply.

Table 2. Operative characteristics of patients with rheumatic valves disease and PH (n = 134).

Variable	Group I (n = 77)	Group II (n = 57)	Total (n = 134)	*p* value
MVR, n (%)	50 (64.9)	36 (63.2)	86 (64.2)	0.832
MV Repair, n (%)	3 (3.9)	0 (0)	3 (2.2)	0.261
DVR, n (%)	24 (31.2)	21 (36.8)	45 (33.6)	0.492
TV Repair, n (%)	16 (20.8)	33 (57.9)	49 (36.6)	0.000
LAA Thrombus	9 (11.7)	8 (14.0)	17 (12.7)	0.687
LAA Plication	28 (36.4)	24 (42.1)	52 (38.8)	0.500
ACC time, min, median (IQR)	71 (48.5–95.5)	89 (64.5–105)	80 (55–100.7)	0.009
CPB time, min, median (IQR)	95 (62.5–124)	120 (96.5–140)	104 (73.8–130)	0.001

ACC time, aortic cross-clamp time; CPB, cardiopulmonary bypass; DVR, double valve replacement; LAA, left atrial appendage; MV Repair, mitral valve repair; MVR, mitral valve replacement; TV Repair, tricuspid valve repair.

Table 3. Short-term outcomes of patients with rheumatic valves disease and PH (n = 134).

Variable	Group I (n = 77)	Group II (n = 57)	Total (n = 134)	*p* value
ICU Stay, hr, median (IQR)	24 (24–46.5)	39 (24–48)	24 (24–48)	0.051
Re-operation for Bleeding, n (%)	4 (5.2)	5 (8.8)	9 (6.7)	0.639
Re-operation for Tamponade, n (%)	4 (5.2)	3 (5.3)	7 (5.2)	0.986
Pleural Effusion Need Drainage	9 (11.7)	3 (5.3)	12 (9.0)	0.198
Post-operative CVA	2 (2.6)	0 (0)	2 (1.5)	0.502
Hospital LOS, day, median (IQR)	6 (5–8)	6 (5–9)	6 (5–8)	0.202
30-Day Mortality, n (%)	3 (3.9)	2 (3.5)	5 (3.7)	0.907
30-Day Re-admission, n (%)	11 (14.3)	7 (12.3)	18 (13.4)	0.736
3-Month Mortality, n (%)	7 (9.1)	7 (12.3)	14 (10.4)	0.551
3-Month Re-admission, n (%)	14 (18.2)	8 (14.0)	22 (16.4)	0.522
Causes of Re-admission, n (%)				0.260
Bleeding	0 (0)	2 (3.5)	2 (1.5)	
Tamponade	1 (1.3)	2 (3.5)	3 (2.2)	
AF	4 (5.2)	1 (1.8)	5 (3.7)	
Effusion	6 (7.8)	1 (1.8)	7 (5.2)	
Heart Failure	2 (2.6)	2 (3.5)	4 (3.0)	
Pneumonia	1 (1.3)	0 (0)	1 (0.7)	

AF, atrial fibrillation; IQR, interquartile range; ICU, Intensive care units; CVA, Cerebrovascular accident; LOS, length of stay.

Overall, the analysis of short-term postoperative outcomes demonstrated broadly comparable results between both groups with no statistically significant differences in major adverse events or mortality (Table 3).

Although median ICU stay was longer in Group II (39 vs. 24 hours), this difference narrowly missed statistical significance (p = 0.051), likely reflecting more cautious monitoring rather than an actual increase in postoperative morbidity. Other postoperative morbidities, including pleural effusion requiring drainage (p = 0.198), postoperative CVA (p = 0.220), and hospital LOS (p = 0.202), were also similar between groups, highlighting the absence of a disproportionate burden of complications attributable to PH severity.

Both 30-day and 3-month all-cause mortality rates remained low (3.7% and 10.4%, respectively) with no significant differences (p = 1.000, p = 0.551). Similarly, readmission rates at 30 days (13.4%, p = 0.736) and 3 months (16.4%, p = 0.522) were consistent across groups. The main causes of readmission were effusion (5.2%) and AF (3.7%), followed by heart failure (3.0%), tamponade (2.2%), bleeding (1.5%), and pneumonia (0.7%), indicating that postoperative arrhythmias and pericardial complications heart failure, were the leading contributors, whereas bleeding, and pulmonary infections were relatively uncommon.

These results indicate that, despite severe PH being traditionally regarded as a high-risk feature, it does not necessarily preclude favorable short-term outcomes, reinforcing the early survival benefit of valve surgery even among high-risk patients.

4. Discussion

RHD remains highly prevalent in Yemen, primarily due to limited access to early diagnosis, secondary prophylaxis, and timely surgical intervention. In our study, short-term postoperative outcomes were broadly comparable between the two groups, with no statistically significant differences in major adverse events or mortality. These findings consistent with previous surgical series demonstrating that, although PH is traditionally recognized as a high-risk factor, mitral valve surgery can achieve acceptable early outcomes when meticulous perioperative care is provided [15,16]. For example, Yang *et al.* [15] reported that patients with moderate-to-severe PH undergoing surgery for mitral stenosis did not experience significantly higher 30-day mortality, although their long-term survival was less favorable compared with those without PH. Similarly, classic and more contemporary studies from diverse settings, including South Asia and sub-Saharan Africa, have confirmed that surgery in advanced PH patients yields symptomatic benefit with acceptable early mortality rates, even when baseline hemodynamics are severely compromised [15–17].

In our study, early mortality remained low despite a high prevalence of severe PH; however, 3-month all-cause mortality increased to 10.4%, with a non-significant difference (12.3% vs. 9.1%, $p = 0.551$). These findings align with regional series indicating that severe PH does not necessarily inflate 30-day mortality, though risk may diverge beyond the first month [16,18].

Earlier Egyptian work focusing on rheumatic MR with severe PH documented an acceptable operative mortality of 10%, consistent with low-to-moderate early risk [19].

A single-center series from Pakistan provides a useful counterpoint among rheumatic patients with moderate-to-severe PH, 30-day mortality reached 11.1%, notably higher than our 3.7% [20]. Indian prospective data that split severe PH into systemic versus supra-systemic strata showed sharp early-risk gradients (3.5% vs. 16.6% operative mortality), highlighting how the hemodynamic ceiling of PH modulates early hazard after MVR [21]. This gradient is compatible with the numerically higher 3-month mortality we observed in Group II, suggesting residual right-sided vulnerability despite relief of the mitral lesion.

A recent West African cohort (Benin) treating predominantly young rheumatic patients documented 90-day mortality of 7.3% overall, lower than our 3-month estimate but not PH-stratified [22]. Taken together, our findings suggest that 30-day mortality in patients with PH following mitral valve surgery falls at the lower end of reported regional ranges. However, the observed increase in mortality by 3-month, particularly in Group II, underscores the persistent burden of right ventricular dysfunction and pulmonary vascular load during the vulnerable post-discharge period. These observations emphasize the importance of structured post-discharge care encompassing anticoagulation management, infection surveillance, and strategies to support right ventricular recovery to mitigate early attrition and improve long-term outcomes in this high-risk population.

The observed non-significant tendency for a longer ICU stays in Group II (median 39 vs. 24 hours; $p = 0.051$) is clinically plausible and likely reflects more cautious monitoring rather than a true escalation in postoperative morbidity. Similar observations have been reported in studies where structured perioperative protocols were applied to patients with advanced PH, including earlier initiation of inotropes and PH-targeted ventilatory strategies, which resulted in comparable event rates despite higher baseline hemodynamic risk [14,15,19,23].

Early readmission rates at 3-month were similar between PH groups, suggesting comparable early recovery trajectories. Although few rheumatic-dominant series have reported short-term readmission rates, the literature consistently identify PH as a determinant of adverse long-term outcomes, particularly when elevated pressures persist after valve correction [18,20].

Mitral valve replacement in rheumatic patients with severe PH is feasible with acceptable early mortality, though these patients remain at higher risk of complications. Early surgical intervention, careful perioperative management, and structured follow-up are essential to improve short- and long-term outcomes. Larger, multicenter studies are needed to confirm these findings and refine long-term management strategies for this high-risk population.

5. Limitations of the Study

This study has several limitations. First, the sample size (n = 134) is relatively small, which may limit the statistical power and generalizability of the findings. Second, PH was assessed using echocardiography-derived sPAP, which may be influenced by hemodynamic fluctuations and operator variability. Third, only short-term outcomes (30-day and 3-month) were evaluated, so long-term results remain unknown. Finally, as a single-center study conducted in a resource-limited setting, the findings may not fully reflect other regional or international contexts.

6. Conclusions

Severe PH in patients with rheumatic mitral valve disease does not independently predict poorer short-term surgical outcomes when managed in specialized centers with meticulous perioperative care. Early mortality, morbidity, and readmission rates were comparable across PH patients, with marked reductions in pulmonary pressures achieved postoperatively. These findings demonstrate the feasibility and safety of mitral valve surgery in resource-limited contexts such as Yemen, while underscoring the importance of structured follow-up and timely intervention to improve long-term survival.

Abbreviations

RHD, rheumatic heart disease; PH, pulmonary hypertension; sPAP, systolic pulmonary artery pressure; TVR, tricuspid valve repair; MVR, mitral valve replacement; LVEF, left ventricular ejection fraction; NYHA, New York Heart Association; CPB, cardiopulmonary bypass; ICU, intensive care unit; CVKTC, cardiovascular and kidney transplantation center; FFP, fresh frozen plasma; PRBCs, packed red blood cells; TTE, transthoracic echocardiography; COPD, chronic obstructive pulmonary disease; BMI, body mass index; AF, atrial fibrillation; CVA, cerebrovascular accident; LAA, left atrial appendage; ACC, aortic cross-clamp; LOS, length of stay; IQR, interquartile range; TR, tricuspid regurgitation; DVR, double valve replacement; MV, mitral valve; MR, mitral regurgitation.

Availability of Data and Materials

Data to support the findings of this study are available on reasonable requests from the corresponding author.

Author Contributions

NasA: Data collection, data analysis, interpretation of results, and drafting the manuscript. AAA: Study supervision, data interpretation, and major contribution to manuscript preparation. MAK: Data acquisition, data interpretation, and critical revision of the manuscript. TN: Data acquisition, data interpretation, and critical revision of the manuscript. SB: Perioperative data acquisition, data interpretation, and manuscript revision. SA: Data verification, data interpretation, and manuscript revision. IA: Clinical data collection, data interpretation, and manuscript revision. FAM: Echocardiographic data acquisition, data interpretation, and manuscript revision. NadA: Data organization, preparation of tables/figures, and manuscript revision. All authors read and approved the final version of the manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

This study was approved by the Ethics Committee of Cardiovascular and kidney transplantation centre, Taiz University (Ethics Code: 0030525) on Dec 21, 2021. This research was conducted ethically in accordance with the World Medical Association Declaration of Helsinki. The participants have signed a written informed consent form.

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Conflict of Interest

The authors declare no conflict of interest.

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