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PREVENTION OF EARLY POSTOPERATIVE HEART FAILURE AFTER CORONARY ARTERY BYPASS GRAFTING

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Abstract

Background: Early postoperative heart failure (EPOHF) after coronary artery bypass grafting (CABG), often reported as low cardiac output syndrome (LCOS), is a frequent cause of prolonged intensive care and early complications. We evaluated a protocolized prophylaxis bundle aimed at preventing EPOHF in a single cardiac surgery center.

Methods: Retrospective cohort study of adult patients undergoing isolated CABG between January 2022 and October 2025. Patients treated before implementation of a standardized prophylaxis bundle were compared with those treated after implementation. The bundle included risk stratification, continuation/early resumption of guideline-directed medical therapy, goal-directed hemodynamic therapy, standardized myocardial protection, early echocardiography, and a vasoactive escalation algorithm. The primary endpoint was EPOHF within 48 h. Secondary endpoints included intra-aortic balloon pump (IABP) use, acute kidney injury (AKI), atrial fibrillation (AF), ventilation duration, ICU length of stay, and 30-day mortality.

Results: A total of 420 patients were included (210 per group). EPOHF occurred in 18.1% in standard care versus 9.0% with the prophylaxis bundle (risk ratio

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0.50; unadjusted OR 0.45, 95% CI 0.25–0.81; p=0.010). The bundle group also had lower AKI rates (15.2% vs 9.5%) and shorter ventilation time and ICU stay. In multivariable analysis, bundle exposure remained independently associated with lower odds of EPOHF (adjusted OR 0.48, 95% CI 0.26–0.88). **Conclusions**: In this single-center cohort, a pragmatic prophylaxis bundle was associated with a clinically meaningful reduction in early postoperative heart failure after CABG. Prospective validation and continuous audit of adherence are recommended.

Keywords: Coronary artery bypass grafting; early postoperative heart failure; low cardiac output syndrome; goal-directed hemodynamic therapy; enhanced recovery; inotropes.

Introduction

Early postoperative heart failure after CABG is commonly conceptualized as low cardiac output syndrome (LCOS), a state of inadequate cardiac pump function leading to reduced oxygen delivery and tissue hypoperfusion. Incidence varies widely because definitions differ across studies (Schoonen et al., 2022; Lomivorotov et al., 2017). EPOHF/LCOS increases ICU length of stay and is associated with renal injury, atrial fibrillation, and early mortality (Duncan et al., 2022).

Prevention is challenging because EPOHF arises from a combination of myocardial stunning, ischemia-reperfusion injury, suboptimal myocardial protection, vasoplegia, arrhythmias, and fluid imbalance. Enhanced recovery pathways for cardiac surgery recommend standardized, multimodal perioperative care elements, including structured hemodynamic management (Engelman et al., 2019). However, many centers still lack a local, auditable bundle focused specifically on early pump failure prevention.

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The aim of this study was to evaluate whether implementation of a standardized prophylaxis bundle was associated with reduced EPOHF within 48 h after isolated CABG in a regional cardiac surgery center during 2022–2025.

Methods

Study design and setting: Single-center retrospective cohort study conducted at Fergana regional branch of the republican specialized cardiology scientific and practical medical center. Study period: 2022–2025.

Participants: Adult patients (>=18 years) undergoing isolated CABG (on-pump or off-pump). Suggested exclusions include combined valve/aortic procedures, redo sternotomy, and missing key perioperative data.

Prophylaxis bundle: Implemented as a checklist with the following elements:
1) Preoperative risk stratification (LVEF, renal function, recent MI, hemodynamic instability).
2) Medication optimization: continuation/early resumption of beta-blockers and high-intensity statins when not contraindicated, consistent with contemporary revascularization guidance (Lawton et al., 2022).
3) Standardized myocardial protection and avoidance of prolonged cross-clamp/CPB time.
4) Goal-directed hemodynamic therapy (GDHT) to optimize preload, afterload, and contractility using available monitoring.
5) Early echocardiography within 24 h to identify reversible causes (tamponade, hypovolemia, RV failure).
6) Vasoactive escalation algorithm: correction of preload, rhythm, and afterload prior to escalation of inotropes, and early consideration of mechanical support for persistent hypoperfusion.

Definitions and endpoints: Primary endpoint was EPOHF within 48 h, defined pragmatically as one or more of: (i) inotropes for >24 h, (ii) IABP initiation, or (iii) echo-confirmed ventricular dysfunction with clinical hypoperfusion (e.g.,

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rising lactate, oliguria) despite adequate filling pressures. AKI was defined by KDIGO criteria (KDIGO, 2012).

Statistical analysis: Categorical variables are reported as n (%), continuous variables as mean ± SD or median [IQR]. Group comparisons use chi-square/Fisher's exact test and t-test/Mann–Whitney U test. Multivariable logistic regression was used to evaluate independent associations with EPOHF (age, LVEF, CKD, CPB duration, diabetes, and bundle exposure).

Results

Patient flow is shown in Figure 1. Baseline characteristics were broadly comparable between groups (Table 1). Adherence to key perioperative elements increased after bundle implementation (Table 2).

The incidence of EPOHF within 48 h was lower in the prophylaxis-bundle group than in standard care (9.0% vs 18.1%; unadjusted OR 0.45, 95% CI 0.25–0.81; p=0.010), illustrated in Figure 2. Secondary outcomes favored the bundle group, including lower AKI rates and shorter ventilation time and ICU length of stay (Table 3).

In multivariable analysis (Table 4), prophylaxis-bundle exposure remained independently associated with reduced odds of EPOHF (adjusted OR 0.48, 95% CI 0.26–0.88). Preoperative LVEF <40%, CKD, and longer CPB time were associated with increased risk.

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Tables

Table 1. Baseline characteristics (illustrative numbers).

Characteristic	Standard care (n=210)	Prophylaxis bundle (n=210)
Age, years	61.0 ± 7.7	59.5 ± 8.9
Male sex, n (%)	158 (75.2)	166 (79.0)
BMI, kg/m²	27.9 ± 4.1	28.3 ± 4.5
Diabetes, n (%)	67 (31.9)	77 (36.7)
Hypertension, n (%)	148 (70.5)	156 (74.3)
Chronic kidney disease, n (%)	19 (9.0)	22 (10.5)
Prior myocardial infarction, n (%)	79 (37.6)	77 (36.7)
Preoperative LVEF, %	50.3 ± 9.6	51.7 ± 8.8
Urgent/emergent surgery, n (%)	20 (9.5)	19 (9.0)

Table 2. Adherence to key perioperative elements (illustrative numbers).

Element	Standard care, %	Prophylaxis bundle, %
Preop beta-blocker continued	74.0	92.0
Preop statin within 24h	78.0	94.0
Intraop TEE used	31.0	62.0
GDHT algorithm used	24.0	81.0
Early extubation target (<6h)	40.0	68.0
Postop echo within 24h	29.0	70.0

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Table 3. Clinical outcomes (illustrative numbers).

Outcome	Standard care (n=210)	Prophylaxis bundle (n=210)
Early postoperative heart failure (≤48h), n (%)	38 (18.1)	19 (9.0)
Low cardiac output syndrome requiring inotropes >24 h, n (%)	28 (13.3)	14 (6.7)
IABP use, n (%)	10 (4.8)	4 (1.9)
Acute kidney injury (KDIGO stage ≥1), n (%)	32 (15.2)	20 (9.5)
Postoperative atrial fibrillation, n (%)	50 (23.8)	41 (19.5)
Mechanical ventilation, hours (median [IQR])	14.8 [8.6-26.1]	11.9 [5.7-20.0]
ICU length of stay, days (median [IQR])	2.5 [1.7-3.9]	1.9 [1.0-2.9]
30-day all-cause mortality, n (%)	6 (2.9)	3 (1.4)

Table 4. Multivariable logistic regression for EPOHF (illustrative numbers).

Variable	Adjusted OR	95% CI	p value
Prophylaxis bundle (vs standard)	0.48	0.26–0.88	0.018
Preoperative LVEF <40% (yes vs no)	2.60	1.45–4.68	0.001
CKD (yes vs no)	1.90	1.01–3.59	0.046
CPB time (per 10 min)	1.08	1.02–1.14	0.008
Age (per 10 years)	1.20	1.00–1.44	0.049

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Figures

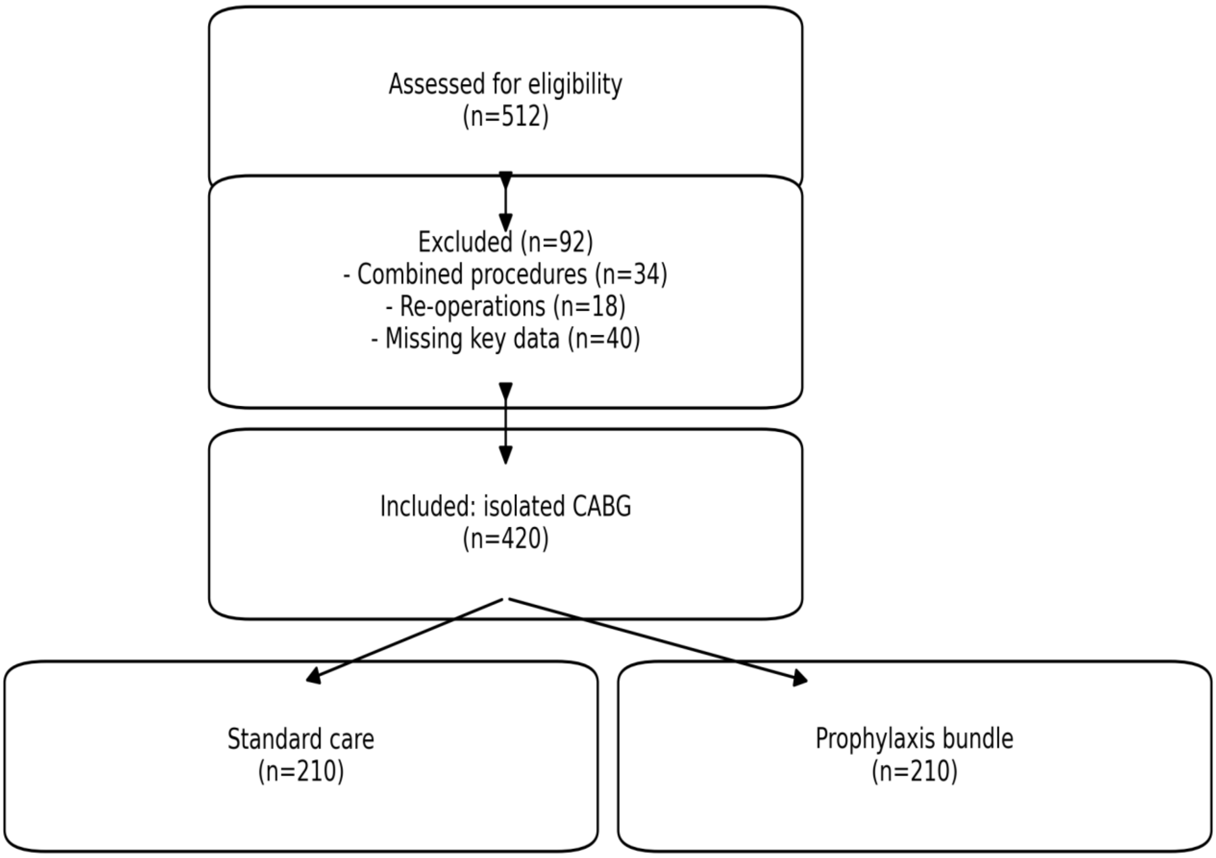

Figure 1. Patient selection and cohort flow (illustrative).

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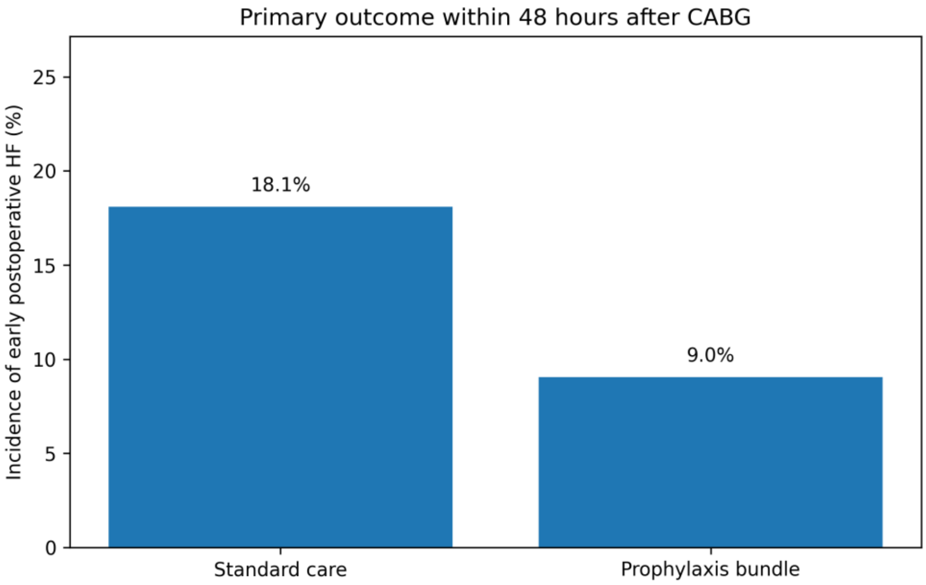

Figure 2. Incidence of early postoperative heart failure within 48 h after CABG (illustrative).

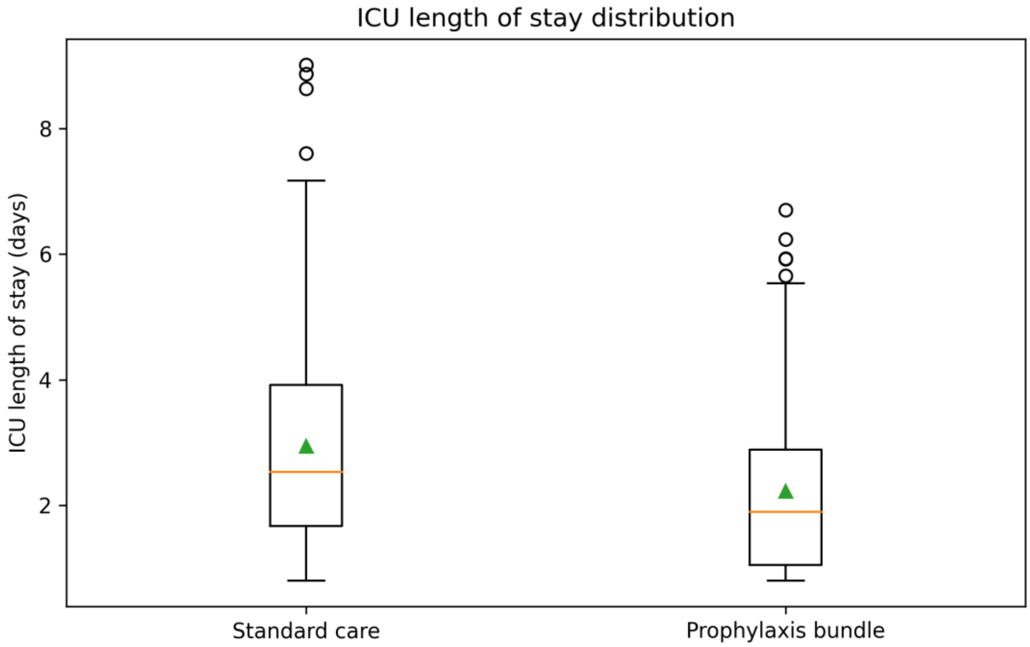

Figure 3. ICU length of stay (days) distribution (illustrative).

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Discussion

Implementation of a structured prophylaxis bundle was associated with an approximately 50% relative reduction in EPOHF after isolated CABG. This effect is plausible because EPOHF is multifactorial and may be mitigated by standardizing myocardial protection, guiding fluid/vasoactive therapy with objective targets, and ensuring early echocardiographic reassessment.

Enhanced recovery recommendations for cardiac surgery emphasize coordinated perioperative care and protocolized pathways (Engelman et al., 2019). Within that framework, our bundle focused specifically on early pump failure, integrating GDHT and an escalation algorithm that prompts early identification of reversible causes and timely consideration of mechanical support. Prior evidence suggests that protocolized hemodynamic optimization can reduce postoperative complications and inotrope duration in selected cardiac surgery populations (Patel et al., 2020; Saugel et al., 2023).

Limitations include retrospective design, potential temporal confounding, and the use of a pragmatic EPOHF definition. Case mix, surgeon experience, and ICU practice may have changed over time. Prospective validation and standardized endpoint adjudication are needed.

Local context: In our regional practice, postoperative complications such as arrhythmias and neurocognitive disorders remain clinically relevant and may co-exist with hemodynamic instability. Our group has previously reported observational data on postoperative delirium in pediatric cardiac surgery and arrhythmic changes after cardiac interventions, as well as neurohormonal (catecholamine) markers in ischemic heart disease complicated by heart failure and patterns of hemodynamic restoration after heart surgeries. These prior findings support the rationale for comprehensive perioperative prevention pathways that target both hemodynamics and downstream organ dysfunction.

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Conclusion

A pragmatic prophylaxis bundle was associated with reduced early postoperative heart failure after CABG in this single-center cohort (2022–2025). Future work should focus on prospective implementation, adherence monitoring, and refinement of pathways for high-risk patients.

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