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Can right ventricular-pulmonary artery coupling predict perioperative right ventricular failure after on-pump cardiac surgery? A systematic review and prognostic evidence map

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Introduction: Perioperative right ventricular (RV) failure after cardiopulmonary bypass (CPB) is clinically important but inconsistently defined.[1] Non-invasive RV-pulmonary artery (RV–PA) coupling has been associated with major morbidity and operative mortality after cardiac surgery,[2] but its ability to predict perioperative RV failure remains uncertain. We evaluated whether RV–PA coupling and conventional right-heart phenotypes provide clinically usable prediction after adult on-pump cardiac surgery.

Methods: We systematically reviewed prognostic-factor evidence in adults undergoing on-pump coronary artery bypass grafting, valve, aortic, or combined cardiac surgery. This congress analysis reflects the locked evidence corpus from database searches through 12 June 2026 plus subsequent citation/rescue review. Core coupling metrics were analyzed separately from conventional RV/pulmonary-hypertension phenotypes and by measurement timing. QUIPS (Quality in Prognostic Studies tool) was used for prognostic-factor studies, PROBAST (Prediction model Risk Of Bias ASsessment Tool) only for true prediction models, and certainty was assessed with GRADE-PF (Grading of Recommendations, Assessment, Development and Evaluations). Meta-analysis required at least three clinically compatible independent cohort families.

Results: Fifty-five reports representing 48 cohort families were included. Ten reports from nine independent families evaluated core RV–PA coupling (**Table 1**). Direct coupling evidence for formal postoperative RV failure and difficult/failed CPB separation was confined to one independent family and consisted of unadjusted threshold-group comparisons; no standalone core-coupling effect addressed explicit RV-directed rescue or RV-specific mechanical circulatory support. Most core-coupling evidence concerned mortality, reported across eight independent families, with several adjusted associations but substantial heterogeneity in markers, thresholds, populations, and follow-up. Conventional preoperative TAPSE (Tricuspid Annular Plane Systolic Excursion) and RV longitudinal strain had broader replicated evidence for mortality, low cardiac output syndrome, and vasoactive/inotropic burden. Outcome non-standardization was marked: 19 direct RVF/RVD, CPB-separation, or rescue definition rows represented 16 distinct archetypes. Of 653 candidate synthesis clusters, seven reached the prespecified three-family gate, but none met full clinical and statistical compatibility; no meta-analysis was performed. High QUIPS risk was most frequent for statistical analysis/reporting (45/55) and confounding (38/55).

Conclusions: RV–PA coupling currently supports perioperative risk enrichment rather than validated prediction of postcardiotomy RV failure. Direct perioperative evidence is sparse, outcome definitions are heterogeneous, and no coupling-based approach has external validation or demonstrated clinical readiness. Standardized definitions, fixed measurement timing, prespecified thresholds, and adjusted multicentre validation are required before routine clinical deployment.

TABLE 1. Summary of evidence.

Evidence layer	Key finding	Certainty
Core RV–PA coupling – RVF/CPB separation	1 independent family; unadjusted threshold-group comparisons; no explicit RV-directed rescue effect	Very low
TAPSE/PASP or TAPSE/sPAP – early mortality	6 independent families; directionally consistent risk enrichment; thresholds/scales heterogeneous	Low
Conventional TAPSE – early mortality	Broader replicated prognostic evidence than direct coupling-endpoint evidence	Low
Preoperative RV longitudinal strain – LCOS/support/mortality	Several adjusted associations; strain conventions and populations heterogeneous	Low
Quantitative synthesis	653 candidate clusters; 7 reached ≥3-family gate; 0 fully compatible	No meta-analysis

CPB = cardiopulmonary bypass; LCOS = low cardiac output syndrome; PASP = pulmonary artery systolic pressure; RV = right ventricle/right ventricular; RVF = right ventricular failure; RV–PA = right ventricular-pulmonary artery; sPAP = systolic pulmonary artery pressure; TAPSE = tricuspid annular plane systolic excursion.

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