Association Between the Red Blood Cell Distribution Width and 30-Day Mortality in Intensive Care Patients Undergoing Cardiac Surgery: A Retrospective Observational Study Based on the Medical Information Mart for Intensive Care-IV Database

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Supplemental Data Table S1. The International Classification of Diseases (ICD) codes used in this study

ICD description	ICD code	ICD version
Percutaneous transluminal coronary angioplasty [PTCA]	0066	9
Extracorporeal circulation auxiliary to open heart surgery	3961	9
Insertion of drug-eluting coronary artery stent(s)	3607	9
Single internal mammary-coronary artery bypass	3615	9
Bypass coronary artery, one artery from left internal mammary, open approach	02100Z9	10
Excision or destruction of other lesions or tissue of the heart, endovascular approach	3734	9
Open and other replacement of aortic valve with tissue graft	3521	9
Insertion of non-drug-eluting coronary artery stent(s)	3606	9
Aortocoronary bypass of two coronary arteries	3612	9
Aortocoronary bypass of three coronary arteries	3613	9
Dilation of the coronary artery, one artery with a drug-eluting intraluminal device, percutaneous approach	027034Z	10
Initial insertion of dual-chamber device	3783	9
Initial insertion of transvenous leads [electrodes] into the atrium and ventricle	3772	9
Replacement of aortic valve with zooplastic tissue, open approach	02RF08Z	10
Bypass coronary artery, two arteries from the aorta with autologous venous tissue, open approach	021109W	10
Aortocoronary bypass of one coronary artery	3611	9
Insertion of pacemaker lead into the right atrium, percutaneous approach	02H63JZ	10
Insertion of pacemaker, dual-chamber into subcutaneous tissue and fascia of the chest, open approach	0JH606Z	10
Replacement of aortic valve with zooplastic tissue, percutaneous approach	02RF38Z	10
Bypass coronary artery, three arteries from the aorta with autologous venous tissue, open approach	021209W	10
Implantation or replacement of automatic cardioverter/defibrillator, total system [AICD]	3794	9
Bypass coronary artery, one artery from the aorta with autologous venous tissue, open approach	021009W	10

Implant of pulsation balloon	3761	9
Open and other replacement of aortic valve	3522	9
Pericardiocentesis	370	9
Open heart valvuloplasty of mitral valve without replacement	3512	9
Aortocoronary bypass of four or more coronary arteries	3614	9
Supplement mitral valve with synthetic substitute, open approach	02UG0JZ	10
Insertion of one vascular stent	0045	9
Insertion of two vascular stents	0046	9
Insertion of three vascular stents	0047	9
Assistance with cardiac output using a balloon pump, continuous	5A02210	10
Automatic implantable cardioverter/defibrillator (AICD) check	8949	9
Bypass coronary artery, one artery from the aorta with autologous arterial tissue, open approach	02100AW	10
Intraoperative cardiac pacemaker	3964	9
Drainage of the pericardial cavity with drainage device, percutaneous approach	0W9D30Z	10
Fluoroscopy of multiple coronary artery bypass grafts using other contrast	B213YZZ	10
Insertion of a temporary transvenous pacemaker system	3778	9
Dilation of coronary artery, one artery, percutaneous approach	02703ZZ	10
Insertion of four or more vascular stents	0048	9
Endovascular replacement of aortic valve	3505	9
Bypass coronary artery, one artery from right internal mammary, open approach	02100Z8	10
Dilation of the coronary artery, one artery with two drug-eluting intraluminal devices, percutaneous approach	027035Z	10
Implantation of cardiac resynchronization defibrillator, total system [CRT-D]	0051	9
Insertion of a defibrillator lead into the right ventricle, percutaneous approach	02HK3KZ	10
Replacement of aortic valve with synthetic substitute, open approach	02RF0JZ	10
Percutaneous balloon valvuloplasty	3596	9
Excision, destruction, or exclusion of left atrial appendage (LAA)	3736	9
Insertion of defibrillator generator into chest subcutaneous tissue and fascia, open approach	0JH608Z	10

Open and other replacement of mitral valve with tissue graft	3523	9
Excision or destruction of other lesions or tissue of the heart, open approach	3733	9
Removal of cardiac rhythm-related device from trunk subcutaneous tissue and fascia, open approach	0JPT0PZ	10
Resection of vessel with replacement, aorta, abdominal	3844	9
Excision of mitral valve, open approach	02BG0ZZ	10
Initial insertion of transvenous lead [electrode] into the ventricle	3771	9
Replacement of mitral valve with zooplastic tissue, open approach	02RG08Z	10
Replacement of thoracic aorta, ascending/arch with synthetic substitute, open approach	02RX0JZ	10
Assistance with cardiac output using an impeller pump, continuous	5A0221D	10
Bypass coronary artery, two arteries from left internal mammary, open approach	02110Z9	10
pericardiotomy	3712	9
Removal of cardiac lead from heart, percutaneous approach	02PA3MZ	10
Supplement tricuspid valve with synthetic substitute, open approach	02UJ0JZ	10
Extirpation of matter from coronary artery, one artery, percutaneous approach	02C03ZZ	10
Bypass coronary artery, four or more arteries from the aorta with autologous venous tissue, open approach	021309W	10
Revision or relocation of cardiac device pocket	3779	9
Implantation of cardiac resynchronization pacemaker without mention of defibrillation, total system [CRT-P]	0050	9
Replacement of any type of pacemaker device with a dual-chamber device	3787	9
Supplement mitral valve with synthetic substitute, percutaneous approach	02UG3JZ	10
Initial insertion of single-chamber device, not specified as rate responsive	3781	9
Insertion of short-term external heart assist system into heart, percutaneous approach	02HA3RZ	10
Occlusion of left atrial appendage with extraluminal device, open approach	02L70CK	10
Fluoroscopy of single coronary artery bypass graft using other contrast	B212YZZ	10

Supplemental Data Table S2. Multivariate Cox regression analysis of the association between the RDW and 30-day mortality without using multiple imputation

Variables	Normal-RDW group	Elevated-RDW group		RDW	
	HR (95% CI)	HR (95% CI)	*P*	HR (95% CI)	*P*
Unadjusted	1	2.32 (1.93–2.80)	< 0.001	1.19 (1.15–1.23)	< 0.001
Model 1*	1	2.18 (1.76–2.70)	< 0.001	1.18 (1.13–1.23)	< 0.001
Model 2†	1	1.93 (1.54–2.41)	< 0.001	1.15 (1.10–1.21)	< 0.001
Model 3‡	1	1.77 (1.41–2.22)	< 0.001	1.13 (1.08–1.18)	< 0.001
Model 4§	1	1.79 (1.43–2.24)	< 0.001	1.13 (1.08–1.18)	< 0.001
Model 5‖	1	1.76 (1.33–2.35)	< 0.001	1.17 (1.10–1.25)	< 0.001

*Models 1–5 were derived from multivariate Cox regression models. Model 1 covariates were adjusted for sex, age, and BMI.

†Model 2 covariates were adjusted for sex, age, BMI, myocardial infarction, congestive heart failure, cerebrovascular disease, chronic pulmonary disease, diabetes with complications, and renal disease.

‡Model 3 covariates were adjusted for sex, age, BMI, myocardial infarction, congestive heart failure, cerebrovascular disease, chronic pulmonary disease, diabetes with complications, renal disease, Charlson comorbidity index, SOFA score, and SAPS II.

§Model 4 covariates were adjusted for sex, age, BMI, myocardial infarction, congestive heart failure, cerebrovascular disease, chronic pulmonary disease, diabetes with complications, renal disease, Charlson comorbidity index, SOFA score, SAPS II, heart rate, MAP, respire rate and SPO_2.

‖Model 5 covariates were adjusted for sex, age, BMI, myocardial infarction, congestive heart failure, cerebrovascular disease, chronic pulmonary disease, diabetes with complications, renal disease, Charlson comorbidity index, SOFA score, SAPS II score, heart rate, MAP, respiratory rate, SpO_2, hemoglobin, platelets, WBCs, BUN, creatinine, glucose, potassium, lactate, PaO_2/FiO_2 ratio, base excess, and GCS.

Abbreviations: RDW, red blood cell distribution width; HR, hazard ratio; CI, confidence interval; BMI: body–mass index; SOFA: sequential organ failure assessment; SAPS, Simplified Acute Physiology Score; MAP: mean arterial pressure; WBC: white blood cell; BUN: blood urea nitrogen; GCS: Glasgow Coma Scale.

Supplemental Data Table S3. Multivariate Cox regression model for predicting the 30-day survival probabilities of the normal-RDW and elevated-RDW groups

Variable	Total (N = 7,596[*])	Normal-RDW group (N = 5,714)	Elevated-RDW group (N = 1,882)	P	Statistic
Survival probability	0.904 ± 0.097	0.927 ± 0.064	0.833 ± 0.137	< 0.001	1,619.556

*Some patients had missing data for different variables, making it necessary to exclude.
patients when building the prediction model. Thus, the total number of patients studied was
7,596 instead of 11,502.

Abbreviation: RDW, red blood cell distribution width.

Supplemental Data Table S4. The predictive value of the RDW

| Variable	AUC (95%CI)
RDW*	0.7029 (0.6793–0.7265)
RDW†	0.6605 (0.6383–0.6828)
SOFA score	0.6081 (0.5805–0.6357)
SOFA score + RDW*	0.7132 (0.6901–0.7363)
SOFA score + RDW†	0.7057 (0.6817–0.7296)
SAPS II	0.6523 (0.6275–0.6772)
SAPS II+RDW*	0.7296 (0.7079–0.7513)
SAPS II+RDW†	0.7256 (0.7037–0.7475)

*RDW was considered a continuous variable where indicated.

†RDW was considered a categorical variable where indicated.

Abbreviations: RDW, red blood cell distribution width; AUC, area under the curve; CI, confidence interval; SOFA: sequential organ failure assessment; SAPS II: Simplified Acute Physiology Score II.

Supplemental Data Table S5. Multivariate linear regression for assessing the association between the RDW and the lengths of hospital and ICU stays

Characteristic	Unadjusted		Adjusted	
	β (95% CI)	*P*	β (95% CI)	*P*
Los at hospital	0.96 (0.87–1.04)	< 0.001	0.32 (0.21–0.43)	< 0.001
Los in ICU	0.42 (0.38–0.47)	< 0.001	0.08 (0.02–0.15)	0.011

Abbreviations: RDW, red blood cell distribution width; ICU, intensive care unit; CI, confidence interval; Los, length of stay.
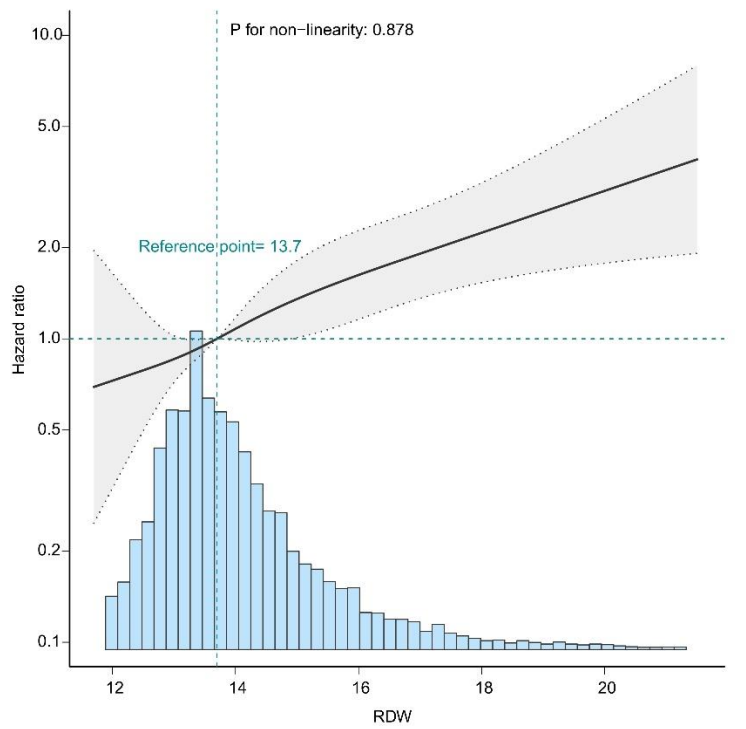
Supplemental Data Fig. S1. Restricted cubic spline data showing the association between the red blood cell distribution width (RDW) and 30-day mortality of patients after undergoing cardiac surgery. The data were fit using a Cox proportional hazard regression model based on restricted cubic splines. The RDW was treated as a continuous variable. The data were adjusted for all factors in Model 5 (Table 3). The curved lines and shaded areas depict the estimated values and their corresponding 95% confidence intervals. Only 99% of the data are displayed.
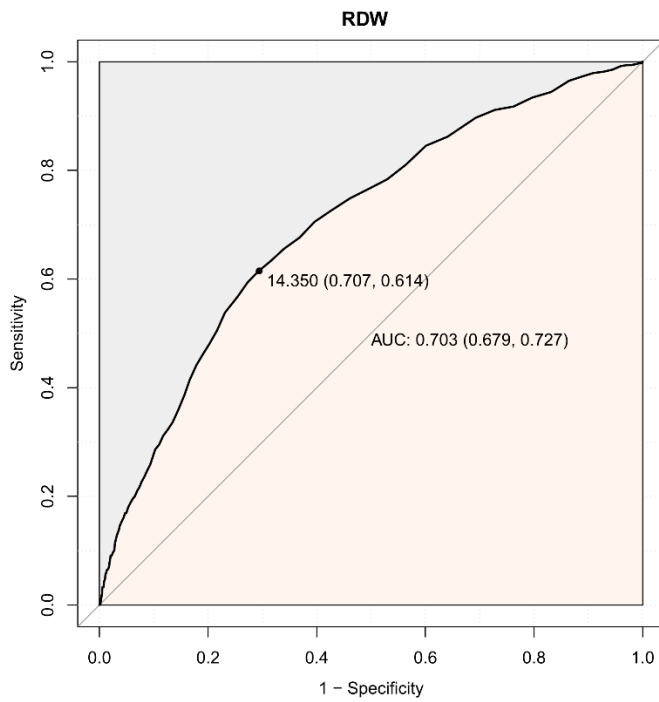
Supplemental Data Fig. S2. An ROC curve used to determine the predictive power of the RDW. The single dot of the ROC curve is the best cut-off value, indicating high specificity and sensitivity.

Abbreviation: ROC, receiver operating characteristic; AUC, area under the curve; RDW, red blood cell distribution width.
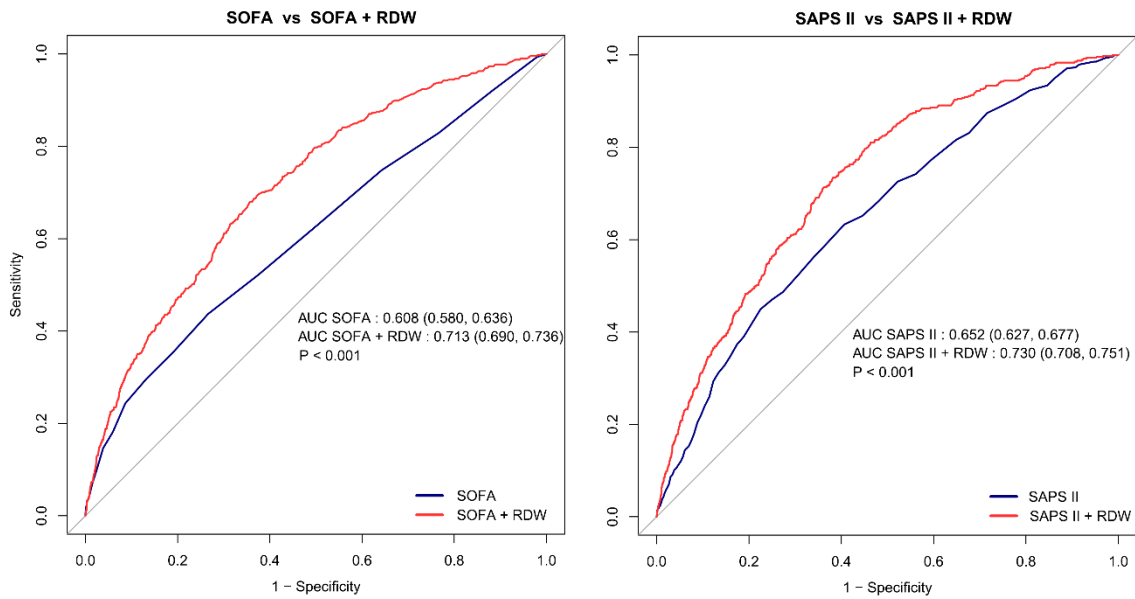
Supplemental Data Fig. S3. ROC curves were plotted to confirm that the RDW could be used to improve the prediction ability in combination with SOFA or SAPS II.

Abbreviations: SOFA, sequential organ failure assessment; RDW, red blood cell distribution width; SAPS II, Simplified Acute Physiology Score II; AUC, area under the curve; ROC, receiver operating characteristic.