

Appendix

Transfusion of red blood cells, fresh frozen plasma, and platelets is associated with mortality and infection after cardiac surgery in a dose-dependent manner

Supplementary Table 1. Risk of all-cause mortality and infection per unit of individual blood products transfused

	Unadjusted OR (95%CI)	P	Adjusted OR (95%CI)	P
Mortality				
RBC	1.25(1.22,1.29)	0.000	1.18(1.14,1.22)*	0.000
FFP	1.38(1.32,1.44)	0.000	1.24(1.18,1.30)#	0.000
PLT	1.18(1.14,1.23)	0.000	1.12(1.07,1.18)\$	0.000
Infection				
RBC	1.25(1.23,1.28)	0.000	1.18(1.15,1.21)*	0.000
FFP	1.31(1.28,1.35)	0.000	1.18(1.14,1.22)#	0.000
PLT	1.15(1.19,1.24)	0.000	1.07(1.03,1.11)\$	0.001
0	Reference		Reference	
0.1-1	1.34(1.06,1.69)	0.015	0.91(0.70,1.17)\$	0.467
1.1-2	2.25(1.52,3.33)	0.000	1.34(0.88,2.04)\$	0.179
>2	8.43(5.85,12.16)	0.000	2.53(1.59,4.02)\$	0.000

* Adjusted by age, gender, body mass index, hypertension, diabetes mellitus, pulmonary hypertension, renal dysfunction, ejection fraction, preoperative hemoglobin, CPB duration, operative procedure, FFP and PLT.

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[§] *Adjusted by age, gender, body mass index, hypertension, diabetes mellitus, pulmonary hypertension, renal dysfunction, ejection fraction, preoperative hemoglobin, CPB duration, operative procedure, RBC and FFP.*

RBC, red blood cells; FFP, fresh frozen plasma; PLT, platelets; CBP, cardiopulmonary bypass

OR, odds ratio; CI, confidence interval

Supplementary Table 2. Perioperative variables in patients with or without RBC transfusion, before and after propensity score matching.

Variable	Before matching			After matching		
	No RBC	RBC	P	No RBC	RBC	P
	(n=4322)	(n=3916)		(n=2165)	(n=2165)	
Demographic characteristics						
Male, n (%)	2249 (52.0)	1238 (31.6)	0.000	763 (35.2)	735 (33.9)	0.371
Ethnicity, Han Chinese, n (%)	4196 (97.1)	3843 (98.1)	0.002	2113 (97.6)	2123 (98.1)	0.240
Age, yr	49 (43,58)	56 (47,64)	0.000	52 (45,60)	53 (45,61)	0.008
Body mass index, kg/m ²	23.3±3.0	22.5±3.0	0.000	22.9±2.9	22.8±3.0	0.059
History of smoking, n (%)	1475 (34.1)	826 (21.1)	0.000	508 (23.5)	490 (22.6)	0.516
Alcohol consumption, n (%)	998 (23.1)	527 (13.5)	0.000	345 (15.9)	332 (15.3)	0.586
Medical history						
NYHA class ≥ III, n (%)	3117 (72.1)	2959 (75.6)	0.000	1550 (71.6)	1633 (75.4)	0.022
Hypertension, n (%)	577 (13.4)	767 (19.6)	0.000	305 (14.1)	334 (15.4)	0.214
Coronary heart disease, n (%)	378 (8.7)	687 (17.5)	0.000	235 (10.9)	259 (12.0)	0.251
Active endocarditis, n (%)	66 (1.5)	130 (3.3)	0.000	43 (2.0)	47 (2.2)	0.670
History of heart failure, n (%)	787 (18.2)	736 (18.8)	0.494	431 (19.9)	400 (18.5)	0.232
Ejection fraction, %	60±9	61±9	0.000	61±8	61±9	0.537
Pulmonary hypertension, n (%)			0.194			0.066
Mild (26-35 mmHg)	227 (5.3)	200 (5.1)		123 (5.7)	92 (4.2)	
Moderate (36-45 mmHg)	382 (8.8)	328 (8.4)		208 (9.6)	184 (8.5)	

Severe (>45 mmHg)	151 (3.5)	176 (4.5)		80 (3.7)	91 (4.2)	
Stroke, n (%)	154 (3.6)	201 (5.1)	0.000	91 (4.2)	90 (4.2)	0.939
Diabetes mellitus, n (%)	197 (4.6)	334 (8.5)	0.000	126 (5.8)	137 (6.3)	0.484
Renal dysfunction, n (%)	132 (3.1)	235 (6.0)	0.000	72 (3.3)	94 (4.3)	0.082
Medications						
Anti-platelet drugs, n (%)	115 (2.7)	213 (5.4)	0.000	74 (3.4)	84 (3.9)	0.418
Anticoagulants, n (%)	625 (14.5)	699 (17.8)	0.000	331 (15.3)	333 (15.4)	0.923
Diuretics, n (%)	3090 (71.5)	2637 (67.3)	0.000	1497 (69.1)	1542 (71.2)	0.135
Laboratory analyses						
Hemoglobin, g/dL	14 (13,15)	13 (12,14)	0.000	13 (12,14)	13 (12,14)	0.004
Platelet count, 10 ⁹ /L	155 (121,194)	150 (111,193)	0.000	155 (118,196)	149 (113,189)	0.001
Abnormal INR, n (%)	711 (16.5)	721 (18.4)	0.019	382 (17.6)	367 (17.0)	0.547
Fibrinogen, mg/dL	3 (2,3)	3 (2,3)	0.000	3 (2,3)	3 (2,3)	0.040
C-reactive protein, mg/L	5.42±10.88	6.92±15.93	0.000	5.73±12.38	5.88±14.65	0.718
Surgical characteristics						
CPB duration, min	109 (86,135)	121 (94,150)	0.000	113 (88,140)	115 (90,142)	0.105
Repeat surgery, n (%)	35 (0.8)	63 (1.6)	0.001	20 (0.9)	31 (1.4)	0.121
Operative procedure, n (%)			0.082			0.082
Valve surgery	4009 (92.8)	3278 (83.7)		1963 (90.7)	1938 (89.5)	
Coronary artery bypass grafting	261 (6.0)	539 (13.8)		162 (7.5)	197 (9.1)	
Combined surgery	52 (1.2)	99 (2.5)		40 (1.8)	30 (1.4)	

Unless otherwise noted, values shown are mean ± SD or median (interquartile range).

RBC, red blood cells; NYHA, New York Heart Association; INR, international normalized ratio; CPB, cardiopulmonary bypass

Supplementary Table 3. Perioperative variables of patients with or without FFP transfusion, before and after propensity score matching (n=4466)

Variable	Before matching		P	After matching		P
	No FFP	FFP		No FFP	FFP	
	(n=5772)	(n=2466)		(n=2233)	(n=2233)	
Demographic characteristics						
Male, n (%)	2364 (41.0)	1123 (45.5)	0.000	894 (40.0)	955 (42.8)	0.064
Ethnicity, Han Chinese, n (%)	5654 (98.0)	2385 (96.7)	0.002	2179 (97.6)	2164 (96.9)	0.044
Age, yr	51 (44,60)	55 (47,63)	0.000	54 (46,62)	55 (46,63)	0.098
Body mass index, kg/m ²	23.0±3.1	22.7±3.0	0.000	22.8±3.1	22.7±3.0	0.146
History of smoking, n (%)	1556 (27.0)	745 (30.2)	0.003	610 (27.3)	638 (28.6)	0.350
Alcohol consumption, n (%)	1058 (18.3)	467 (18.9)	0.515	378 (16.9)	423 (18.9)	0.079
Medical history						
NYHA class ≥ III, n (%)	4206 (72.9)	1870 (75.8)	0.000	1695 (75.9)	1685 (75.5)	0.502
Hypertension, n (%)	882 (15.3)	462 (18.7)	0.000	414 (18.5)	395 (17.7)	0.460
Coronary heart disease, n (%)	625 (10.8)	440 (17.8)	0.000	338 (15.1)	371 (16.6)	0.177
Active endocarditis, n (%)	135 (2.3)	61 (2.5)	0.713	67 (3.0)	54 (2.4)	0.231
History of heart failure, n (%)	1018 (17.6)	505 (20.5)	0.002	432 (19.3)	451 (20.2)	0.475
Ejection fraction, %	61±9	61±9	0.196	61±10	60±9	0.615
Pulmonary hypertension, n (%)			0.507			0.341
Mild (26-35 mmHg)	307 (5.3)	120 (4.9)		131 (5.9)	108 (4.8)	
Moderate (36-45 mmHg)	514 (8.9)	196 (7.9)		189 (8.5)	176 (7.9)	

Severe (>45 mmHg)	223 (3.9)	104 (4.2)		95 (4.3)	89 (4.0)	
Stroke, n (%)	236 (4.1)	119 (4.8)	0.131	113 (5.1)	101 (4.5)	0.401
Diabetes mellitus, n (%)	323 (5.6)	208 (8.4)	0.000	165 (7.4)	170 (7.6)	0.776
Renal dysfunction, n (%)	220 (3.8)	147 (6.0)	0.000	116 (5.2)	119 (5.3)	0.841
Medications						
Anti-platelet drugs, n (%)	181 (3.1)	147 (6.0)	0.000	113 (5.1)	121 (5.4)	0.591
Anticoagulants, n (%)	933 (16.2)	391 (15.9)	0.727	385 (17.2)	354 (15.9)	0.212
Diuretics, n (%)	4042 (70.0)	1685 (68.3)	0.125	1550 (69.4)	1540 (69.0)	0.746
Laboratory analyses						
Hemoglobin, g/dL	14 (12,15)	13 (12,14)	0.000	13 (12,14)	13 (12,14)	0.567
Platelet count, 10 ⁹ /L	155 (119,195)	147 (108,189)	0.000	150 (114,191)	148 (111,190)	0.377
Abnormal INR, n (%)	907 (15.7)	525 (21.3)	0.000	416 (18.6)	439 (19.7)	0.382
Fibrinogen, mg/dL	3 (2,3)	3 (2,3)	0.779	3 (2,3)	3 (2,3)	0.005
C-reactive protein, mg/L	5.96±13.42	6.54±13.81	0.078	6.47±15.19	6.49±13.92	0.964
Surgical characteristics						
CPB duration, min	110 (87,136)	126 (97,156)	0.000	121 (97,148)	122 (95,150)	0.407
Repeat surgery, n (%)	56 (1.0)	42 (1.7)	0.005	28 (1.3)	33 (1.5)	0.519
Operative procedure, n (%)			0.000			0.087
Valve surgery	5237 (90.7)	2050 (83.1)		1929 (86.4)	1886 (84.5)	
Coronary artery bypass grafting	446 (7.7)	354 (14.4)		254 (11.4)	302 (13.5)	
Combined surgery	89 (1.5)	62 (2.5)		50 (2.2)	45 (2.0)	

Unless otherwise noted, values shown are mean ± SD or median (interquartile range).

FFP, fresh frozen plasma; NYHA, New York Heart Association; INR, international normalized ratio; CPB, cardiopulmonary bypass

Supplementary Table 4. Perioperative variables of patients with or without PLT transfusion, before and after propensity score matching (n=2086).

Variable	Before matching		P	After matching		P
	No PLT	PLT		No PLT	PLT	
	(n=7157)	(n=1081)		(n=1043)	(n=1043)	
Demographic characteristics						
Male, n (%)	2889 (40.4)	598 (55.3)	0.000	582 (55.8)	570 (54.7)	0.597
Ethnicity, Han Chinese, n (%)	6986 (97.6)	1053 (97.4)	0.533	1018 (97.6)	1015 (97.3)	0.171
Age, yr	51 (44,60)	57 (48,64)	0.000	57 (48,64)	57 (48,64)	0.530
Body mass index, kg/m ²	22.91±3.04	22.83±3.06	0.442	23.17±2.99	22.78±3.05	0.004
History of smoking, n (%)	1914 (26.7)	387 (35.8)	0.000	391 (37.5)	372 (35.7)	0.388
Alcohol consumption, n (%)	1292 (18.1)	233 (21.6)	0.006	231 (22.1)	226 (21.7)	0.791
Medical history						
NYHA class ≥ III, n (%)	5276 (73.7)	800 (74.0)	0.055	718 (68.9)	780 (74.8)	0.021
Hypertension, n (%)	1071 (15.0)	273 (25.3)	0.000	289 (27.7)	258 (24.7)	0.123
Coronary heart disease, n (%)	703 (9.8)	362 (33.5)	0.000	343 (32.9)	336 (32.2)	0.744
Active endocarditis, n (%)	149 (2.1)	47 (4.3)	0.000	28 (2.7)	45 (4.3)	0.043
History of heart failure, n (%)	1335 (18.7)	188 (17.4)	0.319	180 (17.3)	184 (17.6)	0.818
Ejection fraction, %	61±9	60±9	0.035	61±9	60±9	0.712
Pulmonary hypertension, n (%)			0.002			0.661
Mild (26-35 mmHg)	384 (5.4)	43 (4.0)		51 (4.9)	40 (3.8)	
Moderate (36-45 mmHg)	627 (8.8)	83 (7.7)		79 (7.6)	78 (7.5)	

Severe (>45 mmHg)	289 (4.0)	38 (3.5)		34 (3.3)	38 (3.6)	
Stroke, n (%)	311 (4.3)	44 (4.1)	0.678	47 (4.5)	42 (4.0)	0.588
Diabetes mellitus, n (%)	390 (5.4)	141 (13.0)	0.000	139 (13.3)	129 (12.4)	0.513
Renal dysfunction, n (%)	280 (3.9)	87 (8.0)	0.000	71 (6.8)	80 (7.7)	0.447
Medications						
Anti-platelet drugs, n (%)	265 (3.7)	63 (5.8)	0.001	91 (8.7)	57 (5.5)	0.004
Anticoagulants, n (%)	996 (13.9)	328 (30.3)	0.000	297 (28.5)	305 (29.2)	0.699
Diuretics, n (%)	5002 (69.9)	725 (67.1)	0.060	600 (57.5)	712 (68.3)	0.000
Laboratory analyses						
Hemoglobin, g/dL	14 (12,15)	13 (12,14)	0.000	13 (12,15)	13 (12,14)	0.132
Platelet count, 10 ⁹ /L	155 (121,195)	126 (79,182)	0.000	132 (103,171)	126 (79,183)	0.000
Abnormal INR, n (%)	1232 (17.2)	200 (18.5)	0.298	195 (18.7)	194 (18.6)	0.955
Fibrinogen, mg/dL	3 (2,3)	3 (2,3)	0.017	3 (2,3)	3 (2,3)	0.745
C-reactive protein, mg/L	6.01±13.38	6.91±14.54	0.043	6.48±13.25	6.86±14.55	0.533
Surgical characteristics						
CPB duration, min	112 (88,140)	127 (103,155)	0.000	128 (102,156)	126 (103,154)	0.737
Repeat surgery, n (%)	52 (0.7)	46 (4.3)	0.000	36 (3.5)	39 (3.7)	0.724
Operative procedure, n (%)			0.000			0.009
Valve surgery	6569 (91.8)	718 (66.4)		735 (70.5)	707 (67.8)	
Coronary artery bypass grafting	480 (6.7)	320 (29.6)		249 (23.9)	298 (28.6)	
Combined surgery	108 (1.5)	43 (4.0)		59 (5.7)	38 (3.6)	

Unless otherwise noted, values shown are mean ± SD or median (interquartile range).

PLT, platelets; NYHA, New York Heart Association; INR, international normalized ratio; CPB, cardiopulmonary bypass