

Table 1. Operational definitions of postoperative pulmonary complications

Grade	Definition
1	Cough, dry Microatelectasis: abnormal lung findings and temperature >37.5°C without other documented cause; results of chest radiograph either normal or unavailable Dyspnea, not due to other documented cause
2	Cough, productive, not due to other documented cause Bronchospasm: new wheezing or pre-existent wheezing resulting in change of therapy Hypoxemia: alveolar-arterial gradient >29 and symptoms of dyspnea or wheezing Atelectasis: radiological confirmation plus either temperature >37.5°C or abnormal lung findings Hypercarbia, transient, requiring treatment, such as naloxone or increased manual or mechanical ventilation as an adverse reaction to pulmonary medication
3	Pleural effusion, resulting in thoracentesis Pneumonia, suspected: radiological evidence without bacteriological confirmation Pneumonia, proved: radiological evidence and documentation of pathological organism by Gram stain or culture Pneumothorax Re-intubation postoperatively or intubation, period of ventilator dependence does not exceed 48 hours
4	Ventilatory failure: postoperative ventilator dependence exceeding 48 hours, or re-intubation with subsequent period of ventilator dependence exceeding 48 hours

Table 2. Demographics and clinical variables stratified by %DL_{CO} risk.

	All patients (n = 408)	%DL _{CO} ≥ 70% (n = 338)	%DL _{CO} < 70% (n = 70)	P
Female, n (%)	113 (27.7)	86 (25.4)	27 (38.6)	0.025
Age (y)	66 ± 10.0	66.5 ± 9.7	63.8 ± 11.2	0.036
BMI(kg/m ²)	23.6 ± 3.5	23.6 ± 3.5	23.3 ± 3.4	0.412
BSA (m ²)	1.64 ± 0.19	1.64 ± 0.19	1.62 ± 0.19	0.413
Hypertension, n (%)	330 (80.9)	276 (81.7)	54 (77.1)	0.382
Hyperlipidemia, n (%)	264 (64.7)	219 (64.8)	45 (64.3)	0.936
Smoking, n (%)	264 (64.7)	213 (63.0)	51 (72.9)	0.117
HemoglobinA _{1C} , (%)	6.0 (1.0)	6.0 (0.9)	6.2 (1.3)	0.113
NYHA class (I, II), n (%)	332 (81.4)	275 (81.4)	57 (81.4)	0.382
Recent AMI, n (%)	17 (4.2)	14 (4.1)	3 (4.3)	0.956
Atrial fibrillation, n (%)	79 (19.4)	64 (18.9)	15 (21.4)	0.631
Ex. arteriopathy, n (%)	73 (17.9)	52 (15.4)	21 (30.0)	0.004
EF (%)	57.4 ± 13.7	57.7 ± 13.7	56.0 ± 14.0	0.345
BNP (pg/mL)	205.93 ± 403.7	193.6 ± 381.3	265.3 ± 497.1	0.023*
%VC (%)	94.6 ± 16.3	95.6 ± 16.1	89.6 ± 16.5	0.005
FEV _{1.0} % (%)	72.6 ± 10.6	72.6 ± 10.1	72.4 ± 12.6	0.878
PaO ₂ (mmHg)	89.1 ± 13.2	89.2 ± 2.9	88.5 ± 14.8	0.690
PaCO ₂ (mmHg)	39.7 ± 3.9	39.8 ± 3.9	39.2 ± 4.3	0.328
Hemoglobin (g/dL)	13.0 ± 1.8	13.1 ± 1.7	12.3 ± 1.9	<0.001
Creatinine (mg/dL)	1.3 ± 1.7	1.3 ± 1.7	1.3 ± 1.7	0.306*
Euro Score II	2.05 ± 1.80	1.99 ± 1.75	2.34 ± 1.99	0.051*
STS Score	2.25 ± 2.77	2.21 ± 2.73	2.48 ± 2.98	0.516*
CABG only, n (%)	224 (54.9)	193 (57.1)	31 (44.3)	0.050
Operative time (min)	324.2 ± 80.2	322.5 ± 79.2	332.3 ± 85.3	0.350
Pump time (min)	145.7 ± 50.2	144.3 ± 49.9	152.0 ± 51.5	0.244
Aortic clamp time (min)	105.97 ± 42.3	105.0 ± 42.6	110.2 ± 40.5	0.347
All complications, n (%)	91 (22.3)	64 (18.9)	27 (38.6)	<0.001
Resp. complication, n (%)	71 (17.4)	48 (14.2)	23 (32.9)	<0.001
Hospital mortality, n (%)	6 (1.5)	4 (1.2)	2 (2.9)	0.275

Continuous data are presented as means ± SD.

BMI, body mass index; BNP, brain natriuretic peptide; BSA, body surface area; CABG, coronary artery bypass graft; EF, ejection fraction; Ex., arteriopathy extracardiac arteriopathy; FEV_{1.0}%, percent predicted forced expiratory volume in one second; NYHA, New York Heart Association; %VC, percent predicted vital capacity; Recent AMI, acute myocardial infarction within three months; Resp, respiratory; STS, Society of Thoracic Surgeons; %DL_{CO}, percent predicted diffusing capacity of lung for carbon monoxide

*Fisher exact test or Mann-Whitney test.

Table 3. Demographics of patients and the clinical variables according to complications.

	All complications		P	Respiratory complications		P
	Absent (n = 317)	Present (n = 91)		Absent (n = 337)	Present (n = 71)	
Sex, Female, n (%)	85 (26.8)	28 (30.8)	0.457	89 (26.4)	24 (33.8)	0.206
Age \geq 75 y, n (%)	62 (19.6)	20 (22.0)	0.612	65 (19.3)	17 (23.9)	0.374
BMI(kg/m ²)	23.6 \pm 3.4	23.6 \pm 3.8	0.912	23.6 \pm 3.4	23.4 \pm 3.8	0.610
BSA (m ²)	1.64 \pm 0.2	1.61 \pm 0.09	0.147	1.64 \pm 0.19	1.6 \pm 0.19	0.069
Hypertension, n (%)	255 (80.4)	75 (82.4)	0.673	272 (80.7)	58 (81.7)	0.849
Hyperlipidemia, n (%)	208 (65.6)	56 (61.5)	0.473	221 (65.6)	43 (60.6)	0.442
Smoking, n (%)	202 (63.7)	62 (68.1)	0.438	219 (65.0)	45 (63.4)	0.797
Hemoglobin A1c \geq 7%, n (%)	45 (14.4)	19 (21.1)	0.123	47 (14.2)	17 (23.9)	0.041
NYHA grade > III, n (%)	54 (17.0)	22 (24.2)	0.123	58 (17.2)	18 (25.4)	0.109
Recent AMI, n (%)	15 (4.7)	2 (2.2)	0.286	15 (4.5)	2 (2.8)	0.531
Atrial fibrillation, n (%)	56 (17.7)	23 (25.3)	0.105	60 (17.8)	19 (26.8)	0.083
Ex. arteriopathy, n (%)	57 (18.0)	16 (17.6)	0.930	60 (17.8)	13 (18.3)	0.920
EF < 40%, n (%)	35 (11.0)	13 (14.3)	0.397	38 (11.3)	10 (14.1)	0.504
BNP \geq 100 pg/mL, n (%)	140 (44.7)	54 (60.0)	0.011	152 (45.8)	42 (59.2)	0.041
%DL _{CO} < 70%, n (%)	43 (13.6)	27 (29.7)	<0.001	47 (13.9)	23 (32.4)	<0.001
%VC < 80%, n (%)	45 (14.2)	20 (22.0)	0.074	50 (14.8)	15 (21.1)	0.188
FEV _{1.0} % < 75%, n (%)	158 (49.8)	43 (47.3)	0.663	167 (49.6)	34 (47.9)	0.798
PaO ₂ < 80 mmHg, n (%)	69 (23.3)	16 (18.8)	0.381	72 (22.9)	13 (19.7)	0.575
PaCO ₂ \geq 40 mmHg, n (%)	147 (49.7)	39 (45.9)	0.539	157 (49.8)	29 (43.9)	0.383
Hemoglobin, <11 g/dL, n (%)	36 (11.4)	19 (20.9)	0.019	40 (11.9)	15 (21.1)	0.038
Creatinine \geq 2.0mg/dL, n (%)	23 (7.3)	9 (9.9)	0.410	26 (7.7)	6 (8.5)	0.834
Euro Score II	1.90 \pm 1.58	2.59 \pm 2.34	0.001 [#]	1.91 \pm 1.57	2.72 \pm 2.53	0.003 [*]
STS Score	2.04 \pm 2.51	3.01 \pm 3.44	0.002 [#]	2.09 \pm 2.57	3.06 \pm 3.49	0.006 [*]
CABG alone, n (%)	178 (56.2)	46 (50.5)	0.344	188 (55.8)	36 (50.7)	0.434
Operative time (min)	318.7 \pm 79.8	343.1 \pm 79.4	0.010	320.5 \pm 79.6	341.5 \pm 81.6	0.045
Pump time (min)	140.7 \pm 45.2	163 \pm 61.9	0.002	142.3 \pm 45.7	161.7 \pm 65.9	0.020
Aortic clamp time (min)	103 \pm 38.8	116.2 \pm 51.4	0.025	104 \pm 39.4	115.2 \pm 53.1	0.094

Continuous data are presented as means \pm SD.

BMI, body mass index; BNP, brain natriuretic peptide; BSA, body surface area; CABG, coronary artery bypass graft; EF, ejection fraction; Ex., arteriopathy extracardiac arteriopathy; FEV_{1.0}%, percent predicted forced expiratory volume in one second; NYHA, New York Heart

Association; %VC, percent predicted vital capacity; Recent AMI, acute myocardial infarction within three months; Resp, respiratory; STS, Society of Thoracic Surgeons; %DL_{CO}, percent predicted diffusing capacity of lung for carbon monoxide

*Fisher exact test or Mann-Whitney test.

Table 4. Univariate and multivariate analyses of the predictors of all complications.

	Univariate analysis			Multivariate analysis		
	OR	(95%CI)	P	OR	(95%CI)	P
Sex (female)	1.213	(0.729-2.020)	0.458	0.463	(0.199-1.076)	0.074
Age (≥ 75 y)	1.159	(0.656-2.046)	0.612	0.745	(0.354-1.566)	0.438
BMI(kg/m ²)	1.004	(0.939-1.073)	0.917	1.156	(1.039-1.286)	0.008
BSA (m ²)	1.034	(0.933-1.147)	0.148	0.040	(0.003-0.575)	0.018
Hemoglobin A1c ($\geq 7\%$)	1.539	(0.859-2.758)	0.147	1.744	(0.872-3.4862)	0.116
NYHA class (III, IV)	0.594	(0.878-2.743)	0.126	1.520	(0.794-2.909)	0.206
Atrial fibrillation	1.576	(0.906-2.743)	0.107	1.338	(0.660-2.714)	0.420
BNP (≥ 100 pg/mL)	1.854	(1.150-2.986)	0.011	1.091	(0.614-1.940)	0.767
%DL _{CO} ($< 70\%$)	2.688	(1.547-4.673)	<0.001	2.682	(1.449-4.962)	0.002
%VC ($< 80\%$)	1.703	(0.946-3.065)	0.076	1.243	(0.620-2.491)	0.540
Hemoglobin (< 11 g/dL)	2.060	(1.116-3.803)	0.021	1.306	(0.623-2.735)	0.479
Euro Score II	1.204	(1.069-1.056)	0.002	1.028	(0.857-1.233)	0.763
STS Score	1.113	(1.033-1.200)	0.005	1.080	(0.964-1.211)	0.185
Operative time (min)	1.004	(1.001-1.006)	0.012	0.999	(0.995-1.004)	0.752
Pump time (min)	1.008	(1.004-1.013)	<0.001	1.016	(1.003-1.030)	0.017
Aortic clamp time (min)	1.007	(1.002-1.012)	0.01	0.988	(0.975-1.002)	0.085

OR, odds ratio; CI, confidence interval; BMI, body mass index; BNP, brain natriuretic peptide; BSA, body surface area; NYHA, New York Heart Association; %VC, percent predicted vital capacity; STS, Society of Thoracic Surgeons; %DL_{CO}, percent predicted diffusing capacity of lung for carbon monoxide

Table 5. Univariate and multivariate analyses of predictors of respiratory complications.

	Univariate analysis			Multivariate analysis		
	OR	(95%CI)	P	OR	(95%CI)	P
Sex (female)	1.423	(0.822-2.462)	0.207	0.587	(0.239-1.440)	0.245
Age (≥ 75 y)	1.317	(0.717-2.421)	0.375	0.942	(0.429-2.068)	0.882
BMI(kg/m ²)	1.002	(0.591-1.77)	0.941	1.099	(0.979-1.233)	0.108
BSA(m ²)	0.278	(0.070-1.109)	0.070	0.062	(0.003-1.096)	0.058
HbA1c ($\geq 7\%$)	1.910	(1.020-3.571)	0.043	2.284	(1.102-4.733)	0.026
NYHA class (III, IV)	1.634	(0.892-2.991)	0.112	1.512	(0.751-3.261)	0.246
Atrial fibrillation	1.687	(0.930-3.058)	0.085	1.516	(0.705-3.261)	0.287
BNP (≥ 100 pg/mL)	1.720	(1.020-2.885)	0.042	0.962	(0.514-1.802)	0.904
%DL _{CO} ($< 70\%$)	2.960	(1.647-5.306)	<0.001	2.833	(1.490-5.388)	0.001
%VC ($< 80\%$)	1.537	(0.807-2.928)	0.191	1.022	(0.475-2.196)	0.956
Hemoglobin (< 11 g/dL)	1.989	(1.029-3.842)	0.041	1.356	(0.621-2.963)	0.445
Euro Score II	1.226	(1.084-1.088)	0.001	1.059	(0.876-1.281)	0.553
STS Score	1.106	(1.024-1.195)	0.011	1.044	(0.922-1.182)	0.498
Operative time (min)	1.003	(1.000-1.006)	0.047	0.999	(0.994-1.004)	0.703
Pump time (min)	1.007	(1.002-1.032)	0.004	1.013	(0.999-1.028)	0.066
Aortic clamp time (min)	1.006	(1.000-1.012)	0.043	0.990	(0.976-1.004)	0.168

OR, odds ratio; CI, confidence interval; BMI, body mass index; BNP, brain natriuretic peptide; BSA, body surface area; NYHA, New York Heart Association; %VC, percent predicted vital capacity; STS, Society of Thoracic Surgeons; %DL_{CO}, percent predicted diffusing capacity of lung for carbon monoxide

Table 6. Propensity score ^a analyses of predictors of all and respiratory complications

	All complications			Respiratory complications		
	OR	(95%CI)	P	OR	(95%CI)	P
BSA(m ²)	0.446	(0.040-4.943)	0.511	0.273	(0.021-3.504)	0.319
HbA1c (≥7%)	0.577	(0.149-2.241)	0.427	0.959	(0.245-3.763)	0.953
NYHA class (III,IV)	2.416	(0.797-7.322)	0.119	1.965	(0.616-6.268)	0.254
Atrial fibrillation	1.997	(0.650-6.136)	0.227	1.547	(0.486-4.923)	0.460
BNP (≥100 pg/mL)	0.760	(0.296-1.954)	0.569	0.818	(0.302-2.213)	0.692
%DL _{CO} (<70%)	3.270	(1.356-7.882)	0.008	3.447	(1.343-8.846)	0.010
Euro Score II	1.068	(0.783-1.455)	0.678	1.174	(0.853-1.615)	0.325
STS Score	1.050	(0.882-1.249)	0.586	0.968	(0.800-1.172)	0.740
Operative time (min)	1.005	(0.997-1.013)	0.212	1.003	(0.995-1.012)	0.424
Pump time (min)	1.002	(0.981-1.024)	0.828	1.003	(0.980-1.026)	0.818
Aorta clamp time (min)	1.001	(0.978-1.024)	0.945	1.004	(0.981-1.029)	0.711

a: Propensity scores were calculated by age, sex, BMI, %VC and hemoglobin, and 70 patients with %DL_{CO} <70% and 67 patients with %DL_{CO} ≥70% were matched.

OR, odds ratio; CI, confidence interval; BMI, body mass index; BSA, body surface area;

NYHA, New York Heart Association; %VC, percent predicted vital capacity; STS, Society of Thoracic Surgeons; %DL_{CO} percent predicted diffusing capacity of lung for carbon monoxide