

Figure S1 Adjusted Kaplan-Meier curves of cumulative probabilities of 90-day survival for patients supported by ECMO with or without concomitant ECMO-related infection. ECMO, extracorporeal membrane oxygenation.

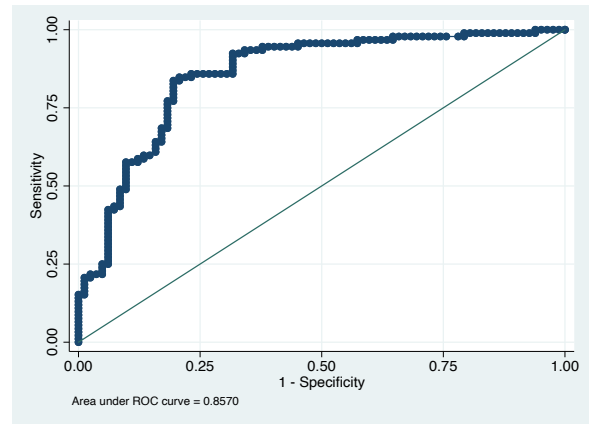


Figure S3 Receiver operating characteristic curve calculated for multivariate logistic regression of 90-day mortality. ROC, receiver operating characteristic.

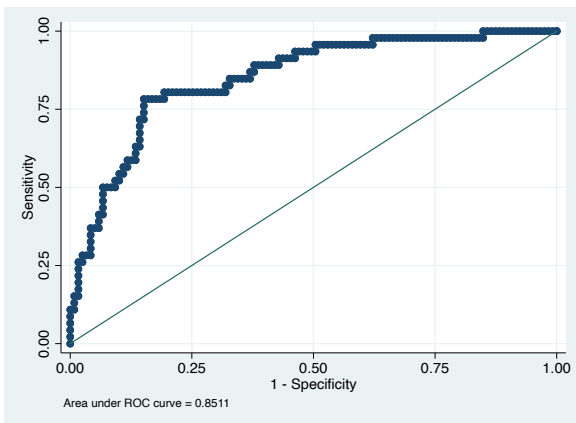


Figure S2 Receiver operating characteristic curve calculated for multivariate logistic regression of ECMO-related infection. ROC, receiver operating characteristic; ECMO, extracorporeal membrane oxygenation.

Table S1 Diagnostic criteria for infections during ECMO

Infection	Clinical features	Site of culture	Bacterial load	Also
Ventilator-associated pneumonia [†]	Two following signs:	Bronchoalveolar lavage	≥10 ⁴ CFU/mL	New or progressive radiographic infiltrate
	(I) The new onset of fever and purulent sputum			
	(II) Leukocytosis/leucopenia			
	(III) Declined oxygenation	Endotracheal aspirate	≥10 ⁵ CFU/mL	
Urinary tract infection [‡]	Fever or tachycardia or hypotension	Catheter urine specimen or midstream urine specimen within the previous 48 hours of removing urethral, suprapubic, or condom catheter	≥10 ³ CFU/mL	–
Blood stream infection	Fever or tachycardia or hypotension + no further sign of localized infection	At least one blood culture For common skin contaminants (coagulase-negative <i>Staphylococci</i> , <i>Corynebacterium</i> species, <i>Bacillus</i> species, <i>Propionibacterium</i> species, <i>Aerococcus</i> species, <i>Micrococcus</i> species), two blood cultures with the same antimicrobial susceptibility profile were mandatory or strong clinical grounds that it is not a contaminant	–	–
Septic shock	(I) The new onset of hypotension and lactate more than 4 mmol/L (II) Need resuscitation or increased vasoactive agents	–	–	Followed by infection during ECMO

[†], 48–72 hours after endotracheal intubation or less than 48 hours after extubation; [‡], at least 48 hours after catheterization. ECMO, extracorporeal membrane oxygenation; CFU, colony forming units.

Table S2 Infection onset times

Variables	VAP (n=24)	UTI (n=1)	BSI (n=21)
Days from hospital admission	6.3 [4.3, 9.1]	10.5	9.6 [4.9, 14.5]
Days from intubation	8.0 [5.6, 11.6]	12.0	9.8 [6.9, 14.2]
Days from ECMO initiation	6.2 [4.4, 8.0]	11.0	8.9 [4.8, 11.6]

Data are presented as median [interquartile range]. VAP, ventilator-associated pneumonia; UTI, urinary tract infection; BSI, blood stream infection; ECMO, extracorporeal membrane oxygenation.

Table S3 Microorganisms associated with various ECMO-related infections

Organism	N (%)
VAP (n=24)	
Gram-negative bacteria	
<i>Acinetobacter baumannii</i>	10 (41.7)
<i>Klebsiella pneumoniae</i>	5 (20.8)
<i>Pseudomonas aeruginosa</i>	2 (8.3)
<i>Stenotrophomonas maltophilia</i>	1 (4.2)
<i>Burkholderia cepacia</i>	1 (4.2)
<i>Serratia marcescens</i>	1 (4.2)
Gram-positive bacteria	
<i>Enterococcus</i> spp.	1 (4.2)
<i>Staphylococcus aureus</i>	1 (4.2)
Fungus	
<i>Candida</i> sp.	2 (8.3)
UTI (n=1)	
Fungus	
<i>Candida tropicalis</i>	1 (100.0)
BSI (n=21)	
Gram-negative bacteria	
<i>Acinetobacter baumannii</i>	7 (33.3)
<i>Klebsiella pneumoniae</i>	5 (23.8)
<i>Burkholderia cepacia</i>	2 (9.5)
Gram-positive bacteria	
<i>Enterococcus</i> spp.	3 (14.3)
<i>Staphylococcus aureus</i>	1 (4.8)
Fungus	
<i>Candida albicans</i>	1 (4.8)
<i>Candida glabrata</i>	1 (4.8)
<i>Trichosporon asahii</i>	1 (4.8)
MDR (n=19)	
Gram-negative bacteria	
<i>Acinetobacter baumannii</i>	12 (63.2)
<i>Klebsiella pneumoniae</i>	6 (31.6)
<i>Burkholderia cepacia</i>	1 (5.3)
Fungus	
	NA

ECMO, extracorporeal membrane oxygenation; VAP, ventilator-associated pneumonia; UTI, urinary tract infection; BSI, blood stream infection; MDR, multi-drug resistant; NA, not available.

Table S4 Laboratory characteristics in patients with and without ECMO-related infection

Variables	Infected patients (n=46)	Uninfected patients (n=128)	P value
Immune status			
Lymphocyte on day 1 ($10^9/L$)	0.60 [0.36, 0.87]	0.92 [0.49, 1.42]	0.005
Lymphocyte on day 2 ($10^9/L$)	0.52 [0.36, 1.09]	0.86 [0.60, 1.41]	<0.001
Lymphocyte on day 3 ($10^9/L$)	0.52 [0.37, 0.72]	0.89 [0.55, 1.24]	<0.001
HLA-DR ⁺ /CD14 ⁺ on day 1 (%) [†]	57.7 [41.5, 92.0]	73.6 [43.5, 92.4]	0.485
Δ Lym ($10^9/L$)	-0.13 [-0.46, 0.09]	-0.02 [-0.49, 0.39]	0.036
Inflammation response			
White blood cell on day 1 ($10^9/L$)	10.56 [6.10, 14.64]	13.70 [7.34, 18.75]	0.048
White blood cell on day 2 ($10^9/L$)	10.32 [7.07, 15.09]	12.26 [8.02, 16.31]	0.262
White blood cell on day 3 ($10^9/L$)	9.52 [7.88, 14.84]	11.72 [7.75, 15.83]	0.265
Δ WBC ($10^9/L$)	0.29 [-2.89, 3.21]	-1.32 [-4.74, 1.97]	0.136
Coagulation			
Platelet on day 1 ($10^9/L$)	111 [73, 187]	144 [104, 204]	0.038
Platelet on day 2 ($10^9/L$)	100 [65, 169]	121 [75, 164]	0.491
Platelet on day 3 ($10^9/L$)	101 [59, 134]	103 [71, 139]	0.735
Δ Plt ($10^9/L$)	-18 [-50, 9]	-31 [-89, 0]	0.434
D-dimer on day 1 ($\mu g/L$)	2,904 [1,196, 5,946]	2,234 [699, 5,402]	0.298
D-dimer on day 2 ($\mu g/L$)	2,905 [1,212, 4,893]	2,440 [879, 5,070]	0.404
D-dimer on day 3 ($\mu g/L$)	2,248 [1,090, 4,273]	2,202 [961, 3,665]	0.796
Δ D-dimer ($\mu g/L$)	-76 [-2,065, 2,129]	123 [-2,194, 1,859]	0.863

Data are presented as median [interquartile range]. [†], missing value 33.3%. ECMO, extracorporeal membrane oxygenation; Δ Lym, difference of lymphocyte count between day 3 and day 1; Δ WBC, difference of white blood cell count between day 3 and day 1; Δ Plt, difference of platelet count between day 3 and day 1; Δ D-dimer, difference of D-dimer between day 3 and day 1.

Table S5 Blood test and coagulation variable between infected patients and non-infected patients

Variables	Infected patients, (n=46)	Uninfected patients, (n=128)	P value
Hemoglobin			
Day 1	99 [90, 123]	122 [102, 135]	0.005
Day 2	104 [89, 120]	109 [92, 121]	0.696
Day 3	101 [92, 112]	100 [89, 111]	0.755
ΔHB	-4 [-16, 10]	-18 [-33, -4]	0.004
Hematocrit			
Day 1	30.1 [26.8, 37.1]	35.8 [30.5, 40.0]	0.003
Day 2	31.3 [27.0, 34.8]	32.0 [26.9, 35.8]	0.758
Day 3	30.5 [27.3, 33.0]	29.8 [26.6, 33.6]	0.993
ΔHCT	-2.1 [-4.6, 3.7]	-4.8 [-9.0, 0.3]	0.023
White blood cell			
Day 1	10.56 [6.10, 14.64]	13.70 [7.34, 18.75]	0.048
Day 2	10.32 [7.07, 15.09]	12.26 [8.02, 16.31]	0.262
Day 3	9.52 [7.88, 14.84]	11.72 [7.75, 15.83]	0.265
ΔWBC	0.29 [-2.89, 3.21]	-1.32 [-4.74, 1.97]	0.136
Lymphocyte			
Day 1	0.60 [0.36, 0.87]	0.92 [0.49, 1.42]	0.005
Day 2	0.52 [0.36, 1.09]	0.86 [0.60, 1.41]	<0.001
Day 3	0.52 [0.37, 0.72]	0.89 [0.55, 1.24]	<0.001
ΔLym	-0.02 [-0.49, 0.39]	-0.13 [-0.46, 0.09]	0.036
Platelet			
Day 1	111 [73, 187]	144 [104, 204]	0.038
Day 2	100 [65, 169]	121 [75, 164]	0.491
Day 3	101 [59, 134]	103 [71, 139]	0.735
ΔPlt	-18 [-50, 9]	-31 [-89, 0]	0.434
Albumin			
Day 1	28.9 [25.0, 33.2]	31.1 [26.8, 36.1]	0.096
Day 2	31.8 [28.8, 34.3]	33.5 [29.0, 37.6]	0.030
Day 3	32.9 [30.6, 38.6]	35.0 [31.0, 39.1]	0.255
ΔALB	4.0 [0, 8.3]	2.1 [-2.0, 7.5]	0.836
Total bilirubin			
Day 1	12.5 [6.3, 22.1]	13.8 [6.9, 23.5]	0.896
Day 2	17.5 [9.8, 27.2]	15.0 [9.7, 26.4]	0.554
Day 3	19.4 [10.7, 33.6]	18.8 [11.3, 33.2]	0.455
ΔTB	5.0 [-5.5, 18.1]	5.4 [-0.6, 14.1]	0.455
Creatinine			
Day 1	109 [73, 169]	101 [71, 176]	0.991
Day 2	132 [78, 165]	121 [79, 192]	0.862
Day 3	109 [76, 170]	116 [75, 179]	0.973
ΔCr	1 [-52, 17]	1 [-25, 26]	0.541
Fibrinogen			
Day 1	4.09 [2.87, 4.78]	3.90 [3.04, 4.69]	0.944
Day 2	3.92 [3.34, 4.64]	3.95 [3.20, 4.69]	0.995
Day 3	4.25 [3.30, 4.71]	4.11 [3.32, 4.77]	0.754
ΔFib	0.36 [-0.59, 1.01]	0.10 [-0.68, 0.94]	0.774
aPTT			
Day 1	38.8 [32.3, 51.9]	41.5 [31.4, 60.3]	0.679
Day 2	40.1 [32.9, 46.9]	38.7 [32.6, 51.4]	0.609
Day 3	41.4 [34.4, 45.0]	38.2 [33.3, 46.9]	0.760
ΔaPTT	1.8 [-13.0, 10.1]	-1.1 [-24.3, 6.9]	0.266
D-dimer			
Day 1	2,904 [1,196, 5,946]	2,234 [699, 5,402]	0.298
Day 2	2,905 [1,212, 4,893]	2,440 [879, 5,070]	0.404
Day 3	2,248 [1,090, 4,273]	2,202 [961, 3,665]	0.796
ΔD-dimer	-76 [-2,065, 2,129]	123 [-2194, 1,859]	0.863

ΔHB, difference of hemoglobin between day 3 and day 1; ΔHCT, difference of hematocrit between day 3 and day 1; ΔWBC, difference of white blood cell count between day 3 and day 1; ΔLym, difference of lymphocyte count between day 3 and day 1; ΔPlt, difference of platelet count between day 3 and day 1; ΔALB, difference of albumin between day 3 and day 1; ΔTB, difference of total bilirubin between day 3 and day 1; ΔCr, difference of creatinine between day 3 and day 1; ΔFib, difference of fibrinogen between day 3 and day 1; aPTT, activated partial thromboplastin time; ΔaPTT, difference of aPTT between day 3 and day 1; ΔD-dimer, difference of D-dimer between day 3 and day 1.

Table S6 Logistic regression analysis of risk factors associated with ECMO-related infection

Factors	Univariable analysis		Multivariable analysis	
	OR (95% CI)	P value	OR (95% CI)	P value
Age (years)	1.013 (0.990, 1.036)	0.279	–	–
Gender [†]	1.197 (0.548, 2.615)	0.651	–	–
Support type [†]				
Veno-venous ECMO	Reference		–	–
Veno-arterial ECMO	0.451 (0.220, 0.925)	0.030	–	–
Immunocompromised status [†]	2.870 (1.084, 7.597)	0.034	–	–
SOFA score	1.112 (1.006, 1.229)	0.038	–	–
Broad-spectrum antibiotics before ECMO cannulation [†]	3.580 (1.763, 7.266)	<0.001	–	–
ECMO duration (days)	1.204 (1.113, 1.302)	<0.001	1.207 (1.096, 1.330)	<0.001
MV duration (days)	1.053 (1.025, 1.082)	<0.001	–	–
RRT during ECMO [†]	1.875 (0.932, 3.771)	0.078	–	–
Decrease in neutrophil count [†]	0.451 (0.208, 0.977)	0.044	–	–
Decrease in lymphocyte count [†]	4.375 (2.097, 5.128)	<0.001	3.578 (2.175, 4.906)	<0.001

[†], analyzed as categorical variables. ECMO, extracorporeal membrane oxygenation; SOFA, Sequential Organ Failure Assessment; MV, mechanical ventilation; RRT, renal replacement therapy; OR, odds ratio; CI, confidence interval.

Table S7 Logistic regression analysis of risk factors associated to 90-day mortality

Factors	Univariable analysis		Multivariable analysis	
	OR (95% CI)	P value	OR (95% CI)	P value
Age (years)	1.032 (1.010, 1.055)	0.003	1.039 (1.011, 1.068)	0.006
Gender [†]	1.039 (0.529, 2.039)	0.912	–	–
Immunocompromised status [†]	5.544 (1.553, 9.794)	0.008	–	–
SOFA score	1.205 (1.093, 1.329)	<0.001	1.154 (1.021, 1.305)	0.022
Diabetes mellitus [†]	2.569 (1.064, 6.206)	0.036	–	–
Broad-spectrum antibiotics before ECMO cannulation [†]	1.749 (0.951, 3.220)	0.072	–	–
ECMO duration (days)	1.084 (1.017, 1.156)	0.013	–	–
RRT during ECMO [†]	4.895 (2.572, 9.318)	<0.001	4.632 (2.055, 0.444)	<0.001
ECMO-related infection [†]	9.743 (3.853, 24.639)	<0.001	4.208 (3.197, 6.524)	<0.001
Decline in lymphocyte count [†]	2.768 (1.490, 5.140)	0.001	–	–

[†], analyzed as categorical variables. SOFA, Sequential Organ Failure Assessment; ECMO, extracorporeal membrane oxygenation; RRT renal replacement therapy; OR, odds ratio; CI, confidence interval.

Table S8 Logistic regression analysis of risk factors associated to ECMO-related infection in patients receiving veno-venous ECMO

Factors	Univariable analysis		Multivariable analysis	
	OR (95% CI)	P value	OR (95% CI)	P value
Age (years)	1.021 (0.989, 1.053)	0.196	–	–
Gender [†]	1.239 (0.473, 3.243)	0.662	–	–
Immunocompromised status [†]	1.833 (0.644, 5.218)	0.256	–	–
SOFA score	1.060 (0.938, 1.197)	0.349	–	–
Broad-spectrum antibiotics before ECMO cannulation [†]	2.000 (0.780, 5.127)	0.149	–	–
ECMO duration (days)	1.141 (1.050, 1.240)	0.002	1.124 (1.017, 1.242)	0.022
MV duration (days)	1.045 (1.013, 1.079)	0.005	–	–
RRT during ECMO [†]	2.687 (1.114, 6.481)	0.028	–	–
Decline in neutrophil count [†]	0.444 (0.162, 1.221)	0.116	–	–
Decline in lymphocyte count [†]	4.390 (2.157, 6.465)	<0.001	3.095 (1.732, 5.580)	0.003

[†], analyzed as categorical variables. ECMO, extracorporeal membrane oxygenation; SOFA, Sequential Organ Failure Assessment; MV, mechanical ventilation; RRT renal replacement therapy; OR, odds ratio; CI, confidence interval.

Table S9 Logistic regression analysis of risk factors associated to ECMO-related infection in patients receiving veno-arterial ECMO

Factors	Univariable Analysis		Multivariable Analysis	
	OR (95% CI)	P value	OR (95% CI)	P value
Age (years)	1.004 (0.968, 1.042)	0.827	–	–
Gender [†]	1.248 (0.309, 5.047)	0.756	–	–
SOFA score	1.279 (1.053, 1.555)	0.013	1.649 (1.160, 2.343)	0.005
Broad-spectrum antibiotics before ECMO cannulation [†]	3.700 (2.149, 5.216)	0.002	–	–
ECMO duration (days)	1.483 (1.170, 1.880)	0.001	1.858 (1.243, 2.778)	0.003
MV duration (days)	1.065 (0.998, 1.136)	0.059	–	–
RRT during ECMO [†]	1.264 (0.380, 4.211)	0.702	–	–
Decline in neutrophil count [†]	0.525 (0.153, 1.799)	0.305	–	–
Decline in lymphocyte count [†]	2.390 (1.364, 4.930)	0.019	1.526 (1.006, 2.313)	0.049

[†], analyzed as categorical variables. ECMO, extracorporeal membrane oxygenation; SOFA, Sequential Organ Failure Assessment; MV, mechanical ventilation; RRT renal replacement therapy; OR, odds ratio; CI, confidence interval.

Table S10 Logistic regression analysis of risk factors associated to ECMO-related infection in patients whose lymphocyte count on day 1 greater than or equal to $1.0 \times 10^9/L$

Factors	Univariable analysis		Multivariable analysis	
	OR (95% CI)	P value	OR (95% CI)	P value
Age (years)	1.017 (0.975, 1.061)	0.440	–	–
Support type [†]				
Veno-venous ECMO	Reference		–	–
Veno-arterial ECMO	0.545 (0.136, 2.187)	0.392	–	–
SOFA score	1.097 (0.895, 1.345)	0.374	–	–
Broad-spectrum antibiotics before ECMO cannulation [†]	3.333 (0.793, 4.010)	0.100	–	–
Immunocompromised status	2.555 (0.376, 4.375)	0.197	–	–
ECMO duration (days)	1.112 (0.970, 1.274)	0.129	–	–
MV duration (days)	1.031 (0.997, 1.067)	0.076	–	–
RRT during ECMO [†]	2.667 (0.521, 6.655)	0.116	–	–
Decline in neutrophil count [†]	0.452 (0.112, 1.821)	0.264	–	–
Decline in lymphocyte count [†]	3.874 (0.938, 6.090)	0.057	2.691 (0.876, 5.717)	0.064

[†], analyzed as categorical variables. ECMO, extracorporeal membrane oxygenation; SOFA, Sequential Organ Failure Assessment; MV, mechanical ventilation; RRT renal replacement therapy; OR, odds ratio; CI, confidence interval.

Table S11 Logistic regression analysis of risk factors associated to ECMO-related infection in patients whose lymphocyte count on day 1 less than $1.0 \times 10^9/L$

Factors	Univariable analysis		Multivariable analysis	
	OR (95% CI)	P value	OR (95% CI)	P value
Age (years)	1.004 (0.975, 1.033)	0.812	–	–
Gender [†]	0.947 (0.392, 2.283)	0.903	–	–
Support type [†]				
Veno-venous ECMO	Reference		–	–
Veno-arterial ECMO	0.737 (0.286, 1.901)	0.528	–	–
SOFA score	1.124 (0.998, 1.267)	0.054	–	–
Broad-spectrum antibiotics before ECMO cannulation [†]	2.600 (1.089, 6.209)	0.031	–	–
Immunocompromised status	1.873 (0.653, 5.370)	0.243	–	–
ECMO duration (days)	1.214 (1.104, 1.335)	<0.001	1.167 (1.007, 1.351)	0.039
MV duration (days)	1.070 (1.029, 1.114)	0.001	–	–
RRT during ECMO [†]	2.245 (0.9831, 5.128)	0.055	–	–
Decline in neutrophil count [†]	0.471 (0.182, 1.214)	0.119	–	–
Decline in lymphocyte count [†]	5.067 (2.875, 9.369)	0.057	4.883 (3.087, 8.357)	0.001

[†], analyzed as categorical variables. ECMO, extracorporeal membrane oxygenation; SOFA, Sequential Organ Failure Assessment; MV, mechanical ventilation; RRT renal replacement therapy; OR, odds ratio; CI, confidence interval.

Table S12 Logistic regression analysis of risk factors associated to ECMO-related infection (exclude immunocompromised patients)

Factors	Univariable analysis		Multivariable analysis	
	OR (95% CI)	P value	OR (95% CI)	P value
Age (years)	1.008 (0.984, 1.033)	0.525	–	–
Gender [†]	0.879 (0.390, 1.984)	0.757	–	–
Support type [†]				
Veno-venous ECMO	Reference		–	–
Veno-arterial ECMO	0.473 (0.220, 1.017)	0.055	–	–
SOFA score	1.149 (1.029, 1.284)	0.014	–	–
Broad-spectrum antibiotics before ECMO cannulation [†]	3.742 (1.730, 8.093)	0.001	–	–
ECMO duration (days)	1.202 (1.102, 1.312)	<0.001	1.124 (1.017, 1.242)	0.022
MV duration (days)	1.049 (1.021, 1.078)	<0.001	–	–
RRT during ECMO [†]	1.846 (0.859, 3.969)	0.116	–	–
Decline in neutrophil count [†]	0.449 (0.187, 1.075)	0.072	–	–
Decline in lymphocyte count [†]	4.380 (1.939, 7.896)	<0.001	3.095 (1.732, 5.580)	0.003

[†], analyzed as categorical variables. ECMO, extracorporeal membrane oxygenation; SOFA, Sequential Organ Failure Assessment; MV, mechanical ventilation; RRT renal replacement therapy; OR, odds ratio; CI, confidence interval.