

**Extracorporeal membrane oxygenation support for failure to wean from cardiopulmonary bypass after pediatric cardiac surgery: analysis of ELSO Registry data**

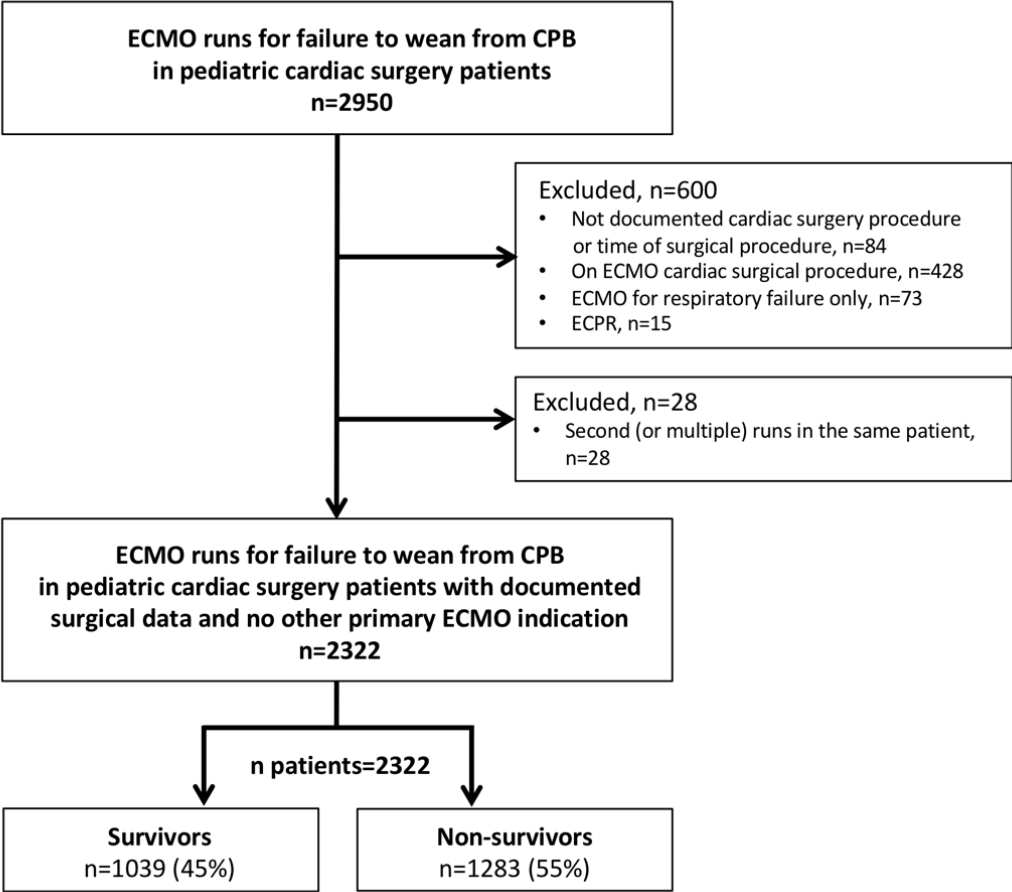
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**Supplemental Digital Content**

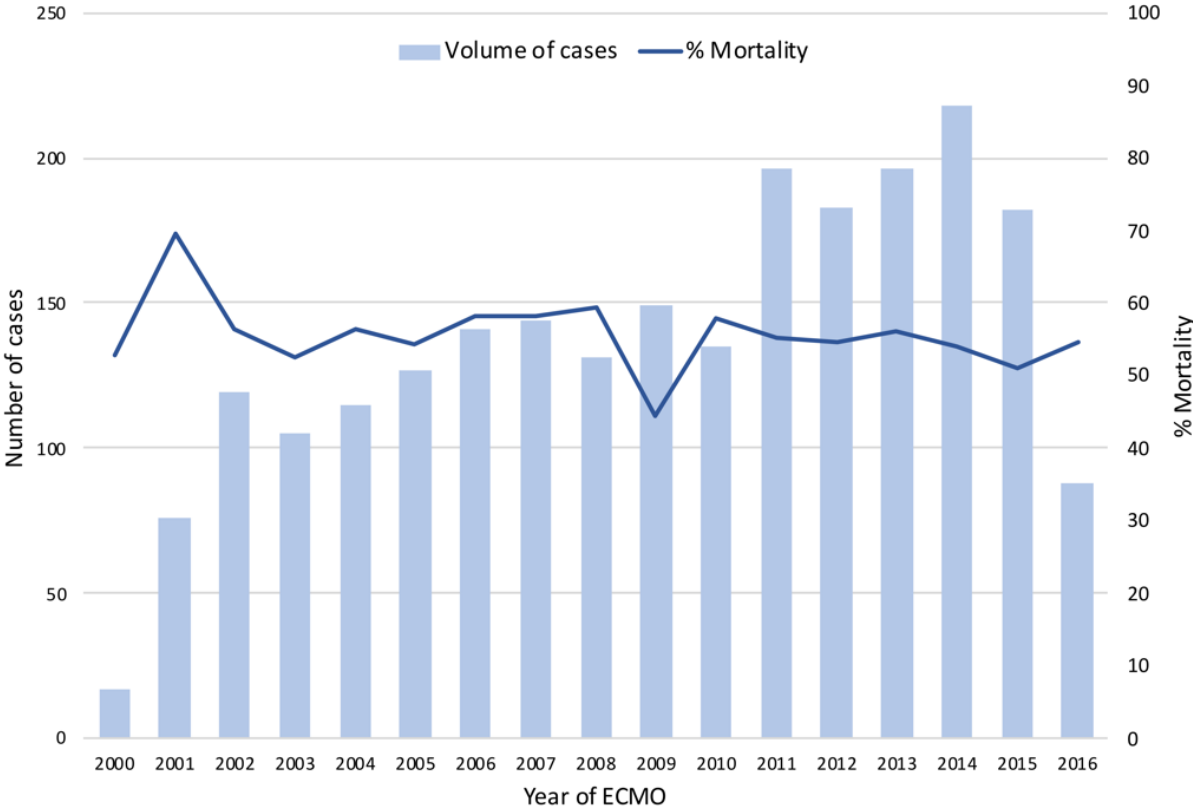
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Supplemental Figure 1. Study flow chart.



**Supplemental Figure 2.** Volume of extracorporeal membrane oxygenation cases of failure to wean from cardiopulmonary bypass per year and associated in-hospital mortality.



**Supplemental Table 1.** Cardiac surgical procedures and associated in-hospital mortality in patients using Extracorporeal Membrane Oxygenation after failure to wean from cardiopulmonary bypass.

Cardiac surgical procedure, n (%)	Total (n=2322)	% Mortality	Survivors (n=1039)	Non-survivors (n=1283)	p-value
ALCAPA/ARCAPA repair	77 (3)	45	42 (4)	35 (3)	0.079
Aortic arch, Coarctation, Supra-aortic stenosis repair	96 (4)	56	42 (4)	54 (4)	0.841
Aortic arch repair in single ventricle physiology	6 (0)	50	3 (0)	3 (0)	1.000 <sup>#</sup>
Aortic arch repair + PA band	20 (1)	50	10 (1)	10 (1)	0.635
Ross, Ross-Konno operation	33 (1)	60	13 (1)	20 (2)	0.533
VSD + Aortic arch repair	34 (2)	62	13 (1)	21 (2)	0.442
Aortic valve surgery/replacement	39 (2)	46	21 (2)	18 (2)	0.249
ASD + isolated PAPVR repair	7 (0)	43	4 (0)	3 (0)	0.707 <sup>#</sup>
ASO	138 (6)	56	61 (6)	77 (6)	0.895
ASO + VSD repair	85 (4)	60	34 (3)	51 (4)	0.370
ASO + Coarctation/Aortic arch repair	36 (2)	64	13 (1)	23 (2)	0.294
Atrial septectomy, isolated	4 (0)	100	0 (0)	4 (0)	0.133 <sup>#</sup>
CAVC repair	84 (4)	56	37 (4)	47 (4)	0.896
Cor triatriatum repair	4 (0)	75	1 (0)	3 (0)	0.633 <sup>#</sup>
VAD positioning	4 (0)	50	2 (0)	2 (0)	1.000 <sup>#</sup>
Coronary surgery repair, not ALCAPA/ARCAPA	15 (1)	40	9 (1)	6 (1)	0.233
Damus-Kaye-Stansel procedure	44 (2)	54	20 (2)	24 (2)	0.924
IAA repair, including Yasui procedure	49 (2)	61	19 (2)	30 (2)	0.396
DORV repair	19 (1)	47	10 (1)	9 (1)	0.488
DORV + ASO, with or without Aortic arch repair	68 (3)	59	28 (3)	40 (3)	0.548
DORV TOF repair	39 (2)	38	24 (2)	15 (1)	0.033
Double switch operation	8 (0)	50	4 (0)	4 (0)	1.000 <sup>#</sup>
Ebstein's anomaly repair, all procedures	30 (1)	60	12 (1)	18 (2)	0.599
Fontan procedure	26 (1)	46	14 (1)	12 (1)	0.348
Glenn procedure	74 (3)	55	33 (3)	41 (3)	0.979
Mustard/Senning procedure for d-TGA	7 (0)	57	3 (0)	4 (0)	1.000 <sup>#</sup>
Mitral valve surgery/replacement	53 (2)	51	26 (3)	27 (2)	0.523
Cardiac tumor surgery	9 (0)	56	4 (0)	5 (0)	0.985
Norwood procedure	515 (22)	58	215 (21)	300 (23)	0.121
RVOTO repair, pulmonary valve surgery/replacement, Branch PA surgery	38 (2)	50	19 (2)	19 (2)	0.511
Pulmonary vein surgery, not TAPVR	5 (0)	80	1 (0)	4 (0)	0.388
RV-PA conduit replacement, isolated	34 (2)	50	17 (2)	17 (1)	0.535
LVOTO surgery including Konno procedure, Subaortic stenosis repair	16 (1)	44	9 (1)	7 (1)	0.353
Systemic-PA shunt	67 (3)	55	30 (3)	37 (3)	0.996
TAPVR repair	123 (5)	64	44 (4)	79 (6)	0.040
TOF + pulmonary atresia repair, including unifocalization	71 (3)	55	32 (3)	39 (3)	0.955
TOF + pulmonary stenosis repair	61 (3)	51	30 (3)	31 (2)	0.480
TOF + CAVC repair	15 (1)	73	4 (1)	11 (1)	0.158
Heart transplant	110 (5)	58	46 (4)	64 (5)	0.527
Truncus arteriosus repair, including Truncus + IAA	76 (3)	45	42 (4)	34 (3)	0.061
Tricuspid valve surgery/replacement	11 (0)	36	7 (1)	4 (0)	0.236 <sup>#</sup>
VSD closure	61 (3)	41	36 (4)	25 (2)	0.023
CAVC + Coarctation/Aortic arch repair	9 (0)	44	5 (1)	4 (0)	0.525
Other procedures*	2 (0)	100	0 (0)	2 (0)	0.505 <sup>#</sup>

ALCAPA: Anomalous Left Coronary Artery from Pulmonary Artery; ARCAPA: Anomalous Right Coronary Artery from Pulmonary Artery; ASD: Atrial Septal Defect; ASO: Aortic Switch Operation; CAVC: Complete Atrioventricular Canal; Cardio-Pulmonary Bypass; DORV: Double Outlet Right Ventricle; d-TGA: d-Transposition of the Great Arteries; ECMO: Extra-Corporeal Membrane Oxygenation; PA: Pulmonary Artery; IAA: Interrupted Aortic Arch; LVOTO: Left Ventricular Outflow Tract Obstruction; PAPVR: Partial Anomalous Pulmonary Venous Return; RV: Right Ventricle; RVOTO: Right Ventricular Outflow Tract Obstruction; TAPVR: Total Anomalous Pulmonary Venous Return; TOF: Tetralogy of Fallot; VAD: Ventricular Assist Device; VSD: Ventricular Septal Defect  
\*Other procedures are palliative ASO in Single Ventricle with Tricuspid Atresia (n=1) and Pericardial Window (n=1); <sup>#</sup>Fisher's Exact Test

**Supplemental Table 2.** Multivariable models of factors associated with mortality in patients using extracorporeal membrane oxygenation after failure to wean from cardiopulmonary bypass.

Variables	Odds Ratio	95% Confidence Interval	p-value
<b>Model I: Pre-ECMO factors</b>			
Demographic and baseline clinical characteristics			
Age (days)			<0.001
≤ 7	1.0	Reference group	-
> 7 and ≤ 26	0.793	0.603-1.042	0.096
> 26 and ≤ 159	0.541	0.409-0.715	<0.001
> 159	0.468	0.345-0.635	<0.001
Race (white)	0.783	0.646-0.948	0.012
Genetic syndrome or congenital anomalies	1.668	1.290-2.157	<0.001
Comorbidities	1.727	1.428-2.087	<0.001
Pre-ECMO cardiac arrest	1.596	1.161-2.194	0.004
Surgery details			
CPB time (min)			<0.001
≤ 174	1	Reference group	-
> 174 and ≤ 251	0.982	0.754-1.279	0.893
> 251 and ≤ 351	1.525	1.166-1.994	0.002
> 351	1.851	1.409-2.431	<0.001
RACHS-1 category			0.003
RACHS-1 1 to 3	1	Reference group	-
RACHS-1 4 to 6	1.449	1.159-1.810	0.001
RACHS not assigned	0.887	0.557-1.415	0.615
Pre-ECMO details			
Pre-ECMO MV duration>24h	1.611	1.319-1.968	<0.001
Pre-ECMO bicarbonate infusion	1.408	1.091-1.818	0.009
<b>Model II: ECMO factors and complications</b>			
ECMO factors			
Left atrium cannulation	0.659	0.494-0.879	0.005
ECMO pump flow at 4h after ECMO initiation (ml/kg/min)			<0.001
≤ 95	1	Reference group	-
> 95 and ≤ 115	1.296	0.985-1.704	0.064
> 115 and ≤ 141	1.529	1.161-2.014	0.003
> 141	1.827	1.379-2.421	<0.001
ECMO support duration (h)			<0.001
≤ 65	1	Reference group	-
> 65 and ≤ 104	0.937	0.711-1.234	0.641
> 104 and ≤ 169	1.732	1.319-2.273	<0.001
> 169	3.873	2.860-5.245	<0.001
On-ECMO details			
FiO2 at 24h after ECMO initiation (%)			0.001
≤ 25	1	Reference group	-
> 25 and ≤ 37	0.639	0.484-0.843	0.002
> 37 and ≤ 40	0.582	0.444-0.764	<0.001
> 40	0.711	0.533-0.948	0.020
Complications			
ECMO circuit complications	1.302	1.060-1.600	0.012
CNS complications	2.189	1.672-2.866	<0.001
Pulmonary hemorrhage	2.811	1.859-4.252	<0.001
Renal failure	1.962	1.428-2.696	<0.001
Hemofiltration required	1.823	1.457-2.280	<0.001

**Model I:** Candidate variables: age, race (white), genetic syndrome or congenital anomalies, comorbidities, pre-ECMO cardiac arrest, CPB time, DHCA, RACHS-1 category, pre-ECMO echocardiography, pre-ECMO MV duration>24h, pre-ECMO bicarbonate infusion  
**N= 1987; Hosmer and Lemeshow Test p value= 0.547; area under the curve= 0.691**

**Model II:** Candidate variables: left atrium cannulation, cardiac and pulmonary failure indication group, ECMO pump flow at 4h, ECMO pump flow at 24h, ECMO support duration, on-ECMO invasive procedures, FiO2 at 24h after ECMO initiation, ECMO circuit complications, CNS complications, cardiac complications, pulmonary hemorrhage, cannulation/surgical site bleeding, hemolysis, disseminate intravascular coagulation, culture proven infection, renal failure, hemofiltration required, arterial pH <7.20, blood glucose >240 mg/dl, hyperbilirubinemia  
**N= 2011; Hosmer and Lemeshow Test p value= 0.331; area under the curve= 0.749**

CNS: Central Nervous System; CPB: Cardio-Pulmonary Bypass; ECMO: Extra-Corporeal Membrane Oxygenation; FiO2: Fraction of inspired Oxygen; RACHS-1: Risk Adjusted Congenital Heart Surgery Score 1; MV: Mechanical Ventilation

**Supplemental Information.** ICD9, ICD10 and CPT web references.

<https://www.ama-assn.org/practice-management/cpt/finding-coding-resources>

[https://www.cdc.gov/nchs/icd/icd10cm\\_pcs\\_resources.htm](https://www.cdc.gov/nchs/icd/icd10cm_pcs_resources.htm)

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