EXCEL REGISTRY REPORT

Annual Report 2020

EXCEL

ACKNOWLEDGEMENTS

The EXCEL Registry is supported by funding from:
National Health and Medical Research Council (NHMRC), **International ECMO Network (ECMO-Net)**, **Heart Foundation**, **The Alfred**, **Barwon Health**, **Critical Care Research Group**, **Royal Prince Alfred Hospital**, and **St Vincent's Hospital Sydney**.

EXCEL Registry Management Committee

Carol Hodgson (Chair)
Ben Fulcher
Shannah Anderson
Jasmin Board
Daniel Brodie
Heidi Buhr
Aidan Burrell
Jamie Cooper
Eddy Fan
John Fraser
David Gattas
Lisa Higgins
Ingrid Hopper
Sue Huckson
Natalie Linke
Ed Litton
Shay McGuiness
Priya Nair
Steve Bernard
Neil Orford
Rachael Parke
Vin Pellegrino
David Pilcher
Benjamin Reddi
Dion Stub
Tony Trapani
Andrew Udy

We would like to thank the participating ECMO centres and patients for their time and generous contribution to this work. The EXCEL Registry is coordinated by the Australian and New Zealand Intensive Care Research Centre (ANZIC-RC) in the School of Public Health and Preventive Medicine, Monash University. We would also like to thank Ms Amanda Martin for her work on producing the reformatting of this report.

CONTENTS

List of Figures

List of Tables


22
8,1
547
7,9
4
1:2,0
525
15
33
52
48
4,0
3,0
1,5
MAK
1,0
60
30

EXECUTIVE SUMMARY

We are delighted to present the annual report for the National ECMO Registry (EXCEL). In this report we provide information on data collected for 276 adult patients receiving ECMO in Australia from 01 January 2020 to 31 December 2020 across 23 healthcare services. In order to determine our capture rate, we cross-referenced the Australian and New Zealand Intensive Care Society (ANZICS) adult patient database, which collects data from 174/183 (95.1%) of adult ICUs across the country. Between the dates June 1, 2020 to December 31, 2020, ANZICS registered 223 unique adult patients receiving ECMO and EXCEL registered 203 unique adult patients receiving ECMO. This indicates that the EXCEL registry was successful in capturing a very high percentage (91%) of ECMO incidences in Australia.

We provide data on demographics, indications for ECMO, admission source and retrievals, risk adjusted mortality, complications, healthcare utilisation, ICU and hospital outcomes and patient reported outcomes at 6-months. Our data follows the patient journey, so that data is not duplicated if a patient is transferred from one hospital to another and it is directly aligned with the international Extracorporeal Life Support Organization (ELSO) registry. We provide direct upload of data from EXCEL to ELSO for healthcare services with a signed agreement. In 2020 we added additional data points to determine the use of ECMO in patients with COVID-19, aligned with the data in the international registry (ELSO). We currently have six registry-embedded clinical trials, including two randomised controlled trials that are funded by the MRFF, that will generate new knowledge about the use of ECMO.

As a collaboration between the NHMRC, the Heart Foundation, the International ECMO Network, the Critical Care Research Group and the ECMO centres in Australia and New Zealand, we aim to monitor long term outcomes, costs of care and to identify best practice. This report is designed to provide feedback to Australian and New Zealand ECMO healthcare providers about service provision, variation in practice and patient outcomes. On request, we have produced new reports for NSW and Victorian sites to compare practice within their jurisdictions, and comparing major centres head-to-head to compare clinical practice and outcomes. We would like to thank all our sites for their dedication and hard work to collect data during the pandemic when the clinical commitments increased.

All data entered in this report has been collected by Investigators and Research Coordinators at each of the participating sites. Data is available to download by the Principal Investigator via the EXCEL REDCap database. Data is provided confidentially to the EXCEL Registry. Site investigators and data collectors will receive the report and it should be shared with hospital staff including members of the hospital executive committee. The report should not be reproduced without permission by the EXCEL Management Committee. Data was extracted on 15 November 2021 and any data entered after this date is not represented in this report. If the report contains less than five patients please be cautious in using this data to inform practice as the data is not generalisable.

This report is presented on behalf of the members of the EXCEL Management Committee, with thanks to Dr Farhad Salimi, Senior Data Analyst, Clinical Outcomes Data Reporting and Research Program. Further information about the EXCEL Registry can be found on the EXCEL website: https://www.monash.edu/medicine/sphpm/anzicrc/research/excel.

If you have any questions please contact EXCEL Chief Investigator Professor Carol Hodgson.

Professor Carol Hodgson.
Head of the Division of Clinical Trials and Cohort Studies, School of Public Health and Preventive Medicine and Deputy Director of the Australian and New Zealand Intensive Care Research Centre, Monash University
Level 3, 553 St Kilda Road, Melbourne, Victoria 3004, Australia
: +61 3 9903 0598
: carol.hodgson@monash.edu

Suggested Citation: Hodgson CL, Anderson S, Salimi F, Bernard S, Board JV, Brodie D, Buhr H, Burrell AJC, Cooper DJ, Fan E, Fraser JF, Fulcher BJ, Gattas DJ, Higgins AM, Hopper IK, Huckson S, Litton E, McGuinness SP, Nair P, Orford N, Parke RL, Pellegrino VA, Pilcher DV, Reddi BAJ, Stub D, Trapani T, Udy AA. EXCEL Registry Annual Report 2020. Monash University, Australian and New Zealand Intensive Care Research Centre, November 2021. 32 pages.

ABBREVIATIONS AND ACRONYMS

Table 1: Abbreviations and Acronyms

AMI	Acute myocardial infarction
ANZICS	Australian and New Zealand Intensive Care Society
ARDS	Acute respiratory distress syndrome
CNS	Central nervous system
COVID-19	Coronavirus disease of 2019
CPR	Cardiopulmonary resuscitation
DVT	Deep vein thromboembolism
ECPR	Extracorporeal cardiopulmonary resuscitation used for advanced resuscitation
ED	Emergency Department
ELSO	Extracorporeal Life Support Organisation
GI	Gastrointestinal
ICU	Intensive Care Unit
IQR	Interquartile range
LA	Left atrium
LOS	Length of stay
LVD	Left ventricular distention
NHMRC	National Health and Medical Research Council
PA	Pulmonary artery
REDCap	Research Electronic Data Capture
RESP	Respiratory ECMO survival prediction
SD	Standard deviation
TBI	Traumatic brain injury
VA	Venoarterial ECMO used for cardiac indication
VAD	Ventricular assist device
VF	Ventricular fibrillation
VV	Venovenous ECMO used for a respiratory indication
WHODAS 2.0 12L	World Health Organisation Disability Assessment Schedule 2.0 12 Level

SITE ENROLMENT

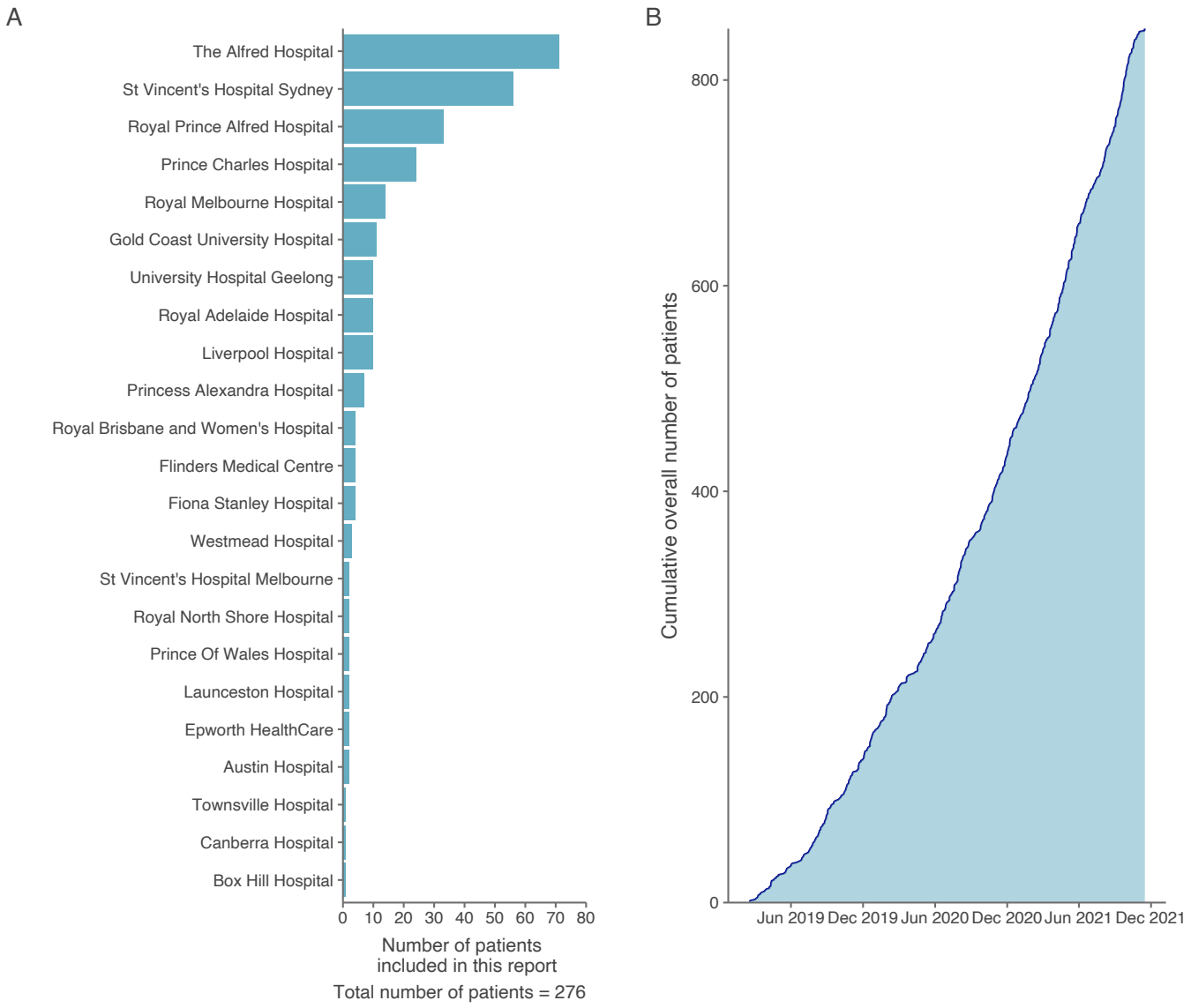


Figure 1: (A) Number of patients included between January 2020 – December 2020 (B) Cumulative overall site enrolment from 2019 to 2021

COVID-19 PATIENTS

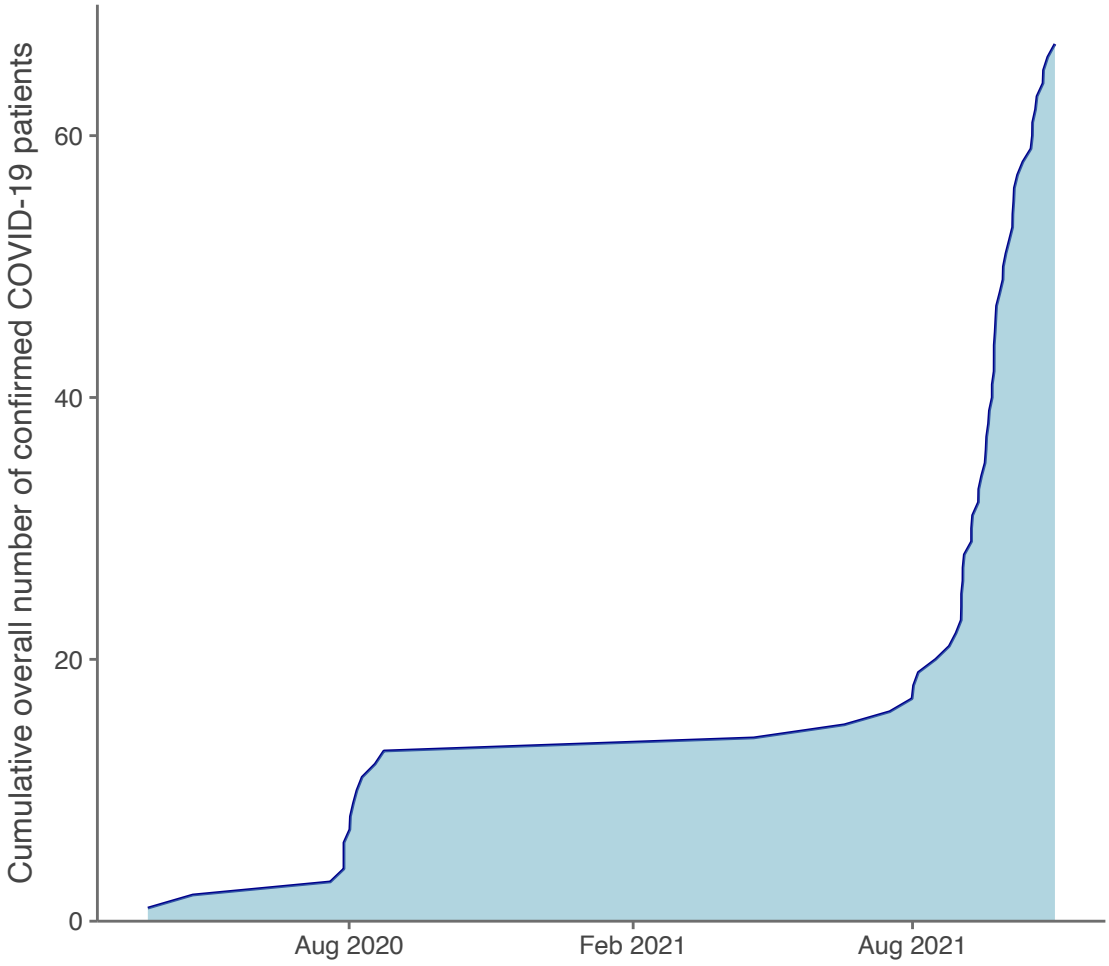


Figure 2: Cumulative overall confirmed COVID-19 patients

DATA COMPLETION

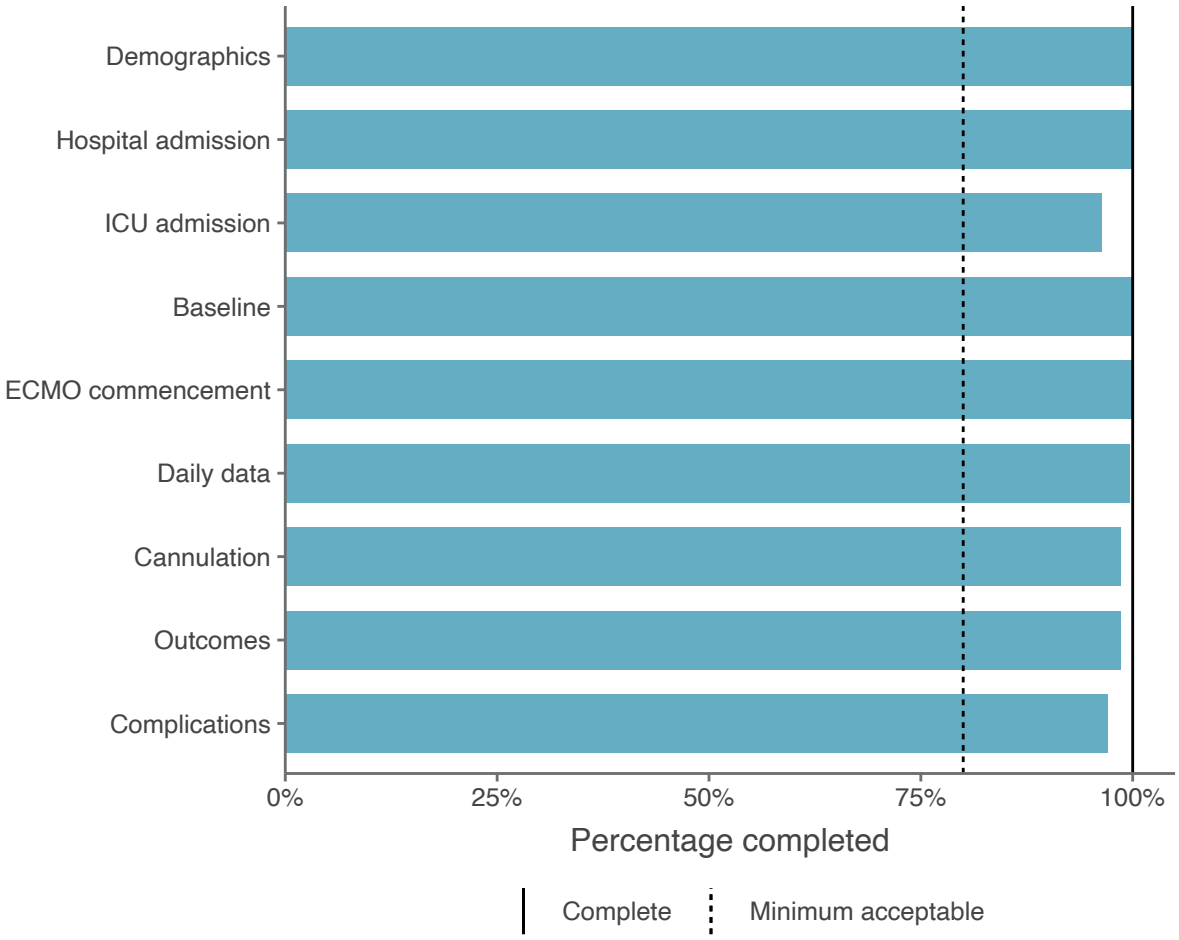
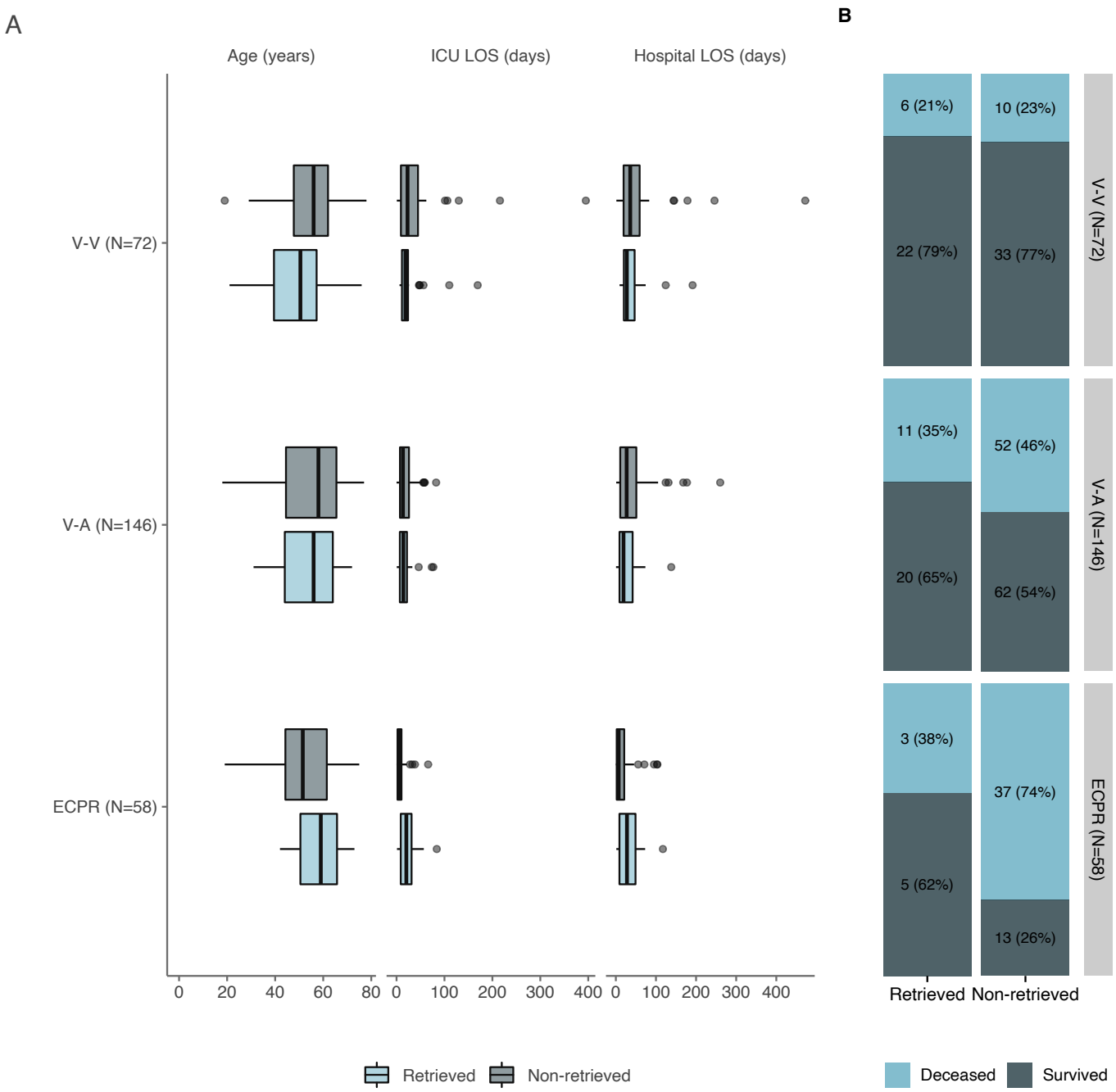


Figure 3: Data completion: EXCEL registry forms

SUMMARY DATA

Table 2: Summary information by ECMO mode

	V-V (N=72)	V-A (N=146)	ECPR (N=58)	Total (N=276)
Age				
Mean (SD)	51.7 (13.9)	55.0 (13.9)	51.8 (14.0)	53.5 (14.0)
Median (IQR)	54.0 (41.8, 60.0)	58.0 (44.0, 65.0)	52.5 (45.0, 62.8)	56.0 (44.0, 64.0)
Range	19.0 - 78.0	18.0 - 77.0	19.0 - 75.0	18.0 - 78.0
Missing	0	0	0	0
ECMO commencement location				
Bedside	55 (76.4%)	60 (41.1%)	43 (74.1%)	158 (57.2%)
Operative theatre	15 (20.8%)	76 (52.1%)	3 (5.2%)	94 (34.1%)
Cath lab	2 (2.8%)	10 (6.8%)	12 (20.7%)	24 (8.7%)
Total	72	146	58	276
Missing	0	0	0	0
ECMO outcome				
Deceased	16 (22.5%)	63 (43.4%)	40 (69.0%)	119 (43.4%)
Survived	55 (77.5%)	82 (56.6%)	18 (31.0%)	155 (56.6%)
Total	71	145	58	274
Missing	1	1	0	2
ICU length of stay (days)				
Mean (SD)	37.3 (57.4)	18.5 (16.4)	11.7 (16.4)	22.1 (33.9)
Median (IQR)	19.8 (10.7, 41.1)	13.7 (7.1, 24.9)	7.2 (2.1, 12.9)	12.8 (6.7, 25.8)
Range	0.6 - 395.0	0.1 - 82.6	0.0 - 83.9	0.0 - 395.0
Missing	1	4	2	7
Hospital length of stay (days)				
Mean (SD)	50.0 (68.2)	36.0 (37.5)	20.6 (28.6)	36.3 (47.0)
Median (IQR)	32.1 (19.4, 52.4)	25.9 (9.5, 47.3)	8.4 (2.2, 26.2)	23.1 (9.1, 46.6)
Range	1.3 - 472.1	0.5 - 260.2	0.1 - 117.3	0.1 - 472.1
Missing	2	3	0	5



Note: Non-retrieved patients received ECMO at one centre and were not transported from one ECMO centre to another

Figure 4: Summary data for patients who were retrieved on ECMO

Pre-ECMO DATA

Data collected immediately prior to ECMO commencement.

Indications

Table 3: ECMO indication (V-V)

	Overall (N=72)
Respiratory indication	
ARDS (risk factor)	42 (62.7%)
Asthma	3 (4.5%)
Chronic end stage lung disease	3 (4.5%)
Direct lung trauma	3 (4.5%)
Drug/toxin pulmonary disease	2 (3.0%)
Focal lung disease (not ARDS)	6 (9.0%)
Post lung transplant	5 (7.5%)
Pulmonary vasculitis/haemorrhage	3 (4.5%)
Total	67
Missing	5

Table 4: ECMO indication (V-A)

	Overall (N=146)
Cardiac indication	
Peri-operative support	39 (28.1%)
Acute myocardial infarction (AMI)	31 (22.3%)
Acute decompensated heart failure	20 (14.4%)
Post heart transplant	13 (9.4%)
Pulmonary embolism	10 (7.2%)
Chronic cardiomyopathy	9 (6.5%)
Myocarditis	8 (5.8%)
Septic shock	4 (2.9%)
Primary arrhythmia (Channelopathy)	2 (1.4%)
Toxic	2 (1.4%)
Advanced pulmonary hypertension	1 (0.7%)
Total	139
Missing	7

Table 5: ECMO indication (ECPR)

	Overall (N=58)
Indication	
Acute myocardial infarction (AMI)	27 (48.2%)
Primary arrhythmia (Channelopathy)	7 (12.5%)
Pulmonary embolism	6 (10.7%)
Peri-operative support	3 (5.4%)
Toxic	3 (5.4%)
Septic shock	2 (3.6%)
Chronic cardiomyopathy	2 (3.6%)
Congenital heart disease	2 (3.6%)
Acute decompensated heart failure	1 (1.8%)
Post heart transplant	1 (1.8%)
Chronic graft (heart) dysfunction	1 (1.8%)
Advanced pulmonary hypertension	1 (1.8%)
ARDS (risk factor)	0 (0.0%)
Myocarditis	0 (0.0%)
Post lung transplant	0 (0.0%)
Pulmonary vasculitis/haemorrhage	0 (0.0%)
Direct lung trauma	0 (0.0%)
Focal lung disease (not ARDS)	0 (0.0%)
Drug/toxin pulmonary disease	0 (0.0%)
Asthma	0 (0.0%)
Chronic end stage lung disease	0 (0.0%)
Total	56
Missing	2

Admission

Table 6: Hospital and ICU admission source

	Overall (N=276)
Hospital admission source	
Home	148 (53.6%)
Other acute hospital ICU	81 (29.3%)
Other acute hospital (not ICU/ED)	33 (12.0%)
Other hospital ED (like ICU above)	13 (4.7%)
Rehabilitation	1 (0.4%)
Total	276
Missing	0
ICU admission source	
Operative theatre/recovery	88 (32.0%)
ICU, other hospital	72 (26.2%)
Emergency department	53 (19.3%)
Ward	31 (11.3%)
Other hospital	18 (6.5%)
Catheter lab	11 (4.0%)
ICU, same hospital	1 (0.4%)
Direct ICU admission (from home)	1 (0.4%)
Total	275
Missing	1

ECMO DATA

Length of stay

Table 7: Length of stay (days) stratified by ECMO type

	V-V (N=72)	V-A (N=146)	ECPR (N=58)	Total (N=276)
ECMO duration				
Median (IQR)	6.9 (3.4, 11.6)	5.7 (3.0, 8.9)	2.8 (1.3, 6.9)	5.6 (2.8, 9.1)
Total	72	141	56	269
Missing	0	5	2	7
ICU length of stay (days)				
Median (IQR)	19.8 (10.7, 41.1)	13.7 (7.1, 24.9)	7.2 (2.1, 12.9)	12.8 (6.7, 25.8)
Total	71	142	56	269
Missing	1	4	2	7
Hospital length of stay (days)				
Median (IQR)	32.1 (19.4, 52.4)	25.9 (9.5, 47.3)	8.4 (2.2, 26.2)	23.1 (9.1, 46.6)
Total	70	143	58	271
Missing	2	3	0	5

Table 8: Length of stay (days) stratified by transfer status

	Retrieved (N=67)	Non-retrieved (N=209)	Total (N=276)
ECMO duration			
Median (IQR)	7.0 (3.7, 11.9)	4.9 (2.5, 8.4)	5.6 (2.8, 9.1)
Total	66	203	269
Missing	1	6	7
ICU length of stay (days)			
Median (IQR)	17.2 (9.4, 23.2)	11.8 (5.7, 26.8)	12.8 (6.7, 25.8)
Total	66	203	269
Missing	1	6	7
Hospital length of stay (days)			
Median (IQR)	24.2 (11.4, 42.4)	22.4 (7.5, 48.4)	23.1 (9.1, 46.6)
Total	67	204	271
Missing	0	5	5

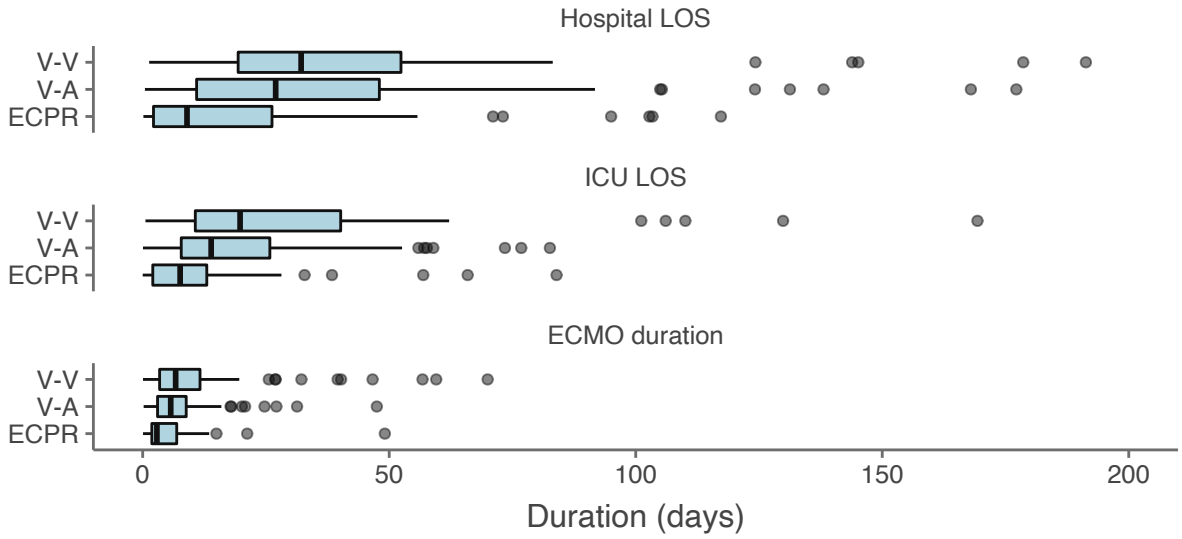


Figure 5: Distribution of length of stay stratified by ECMO mode

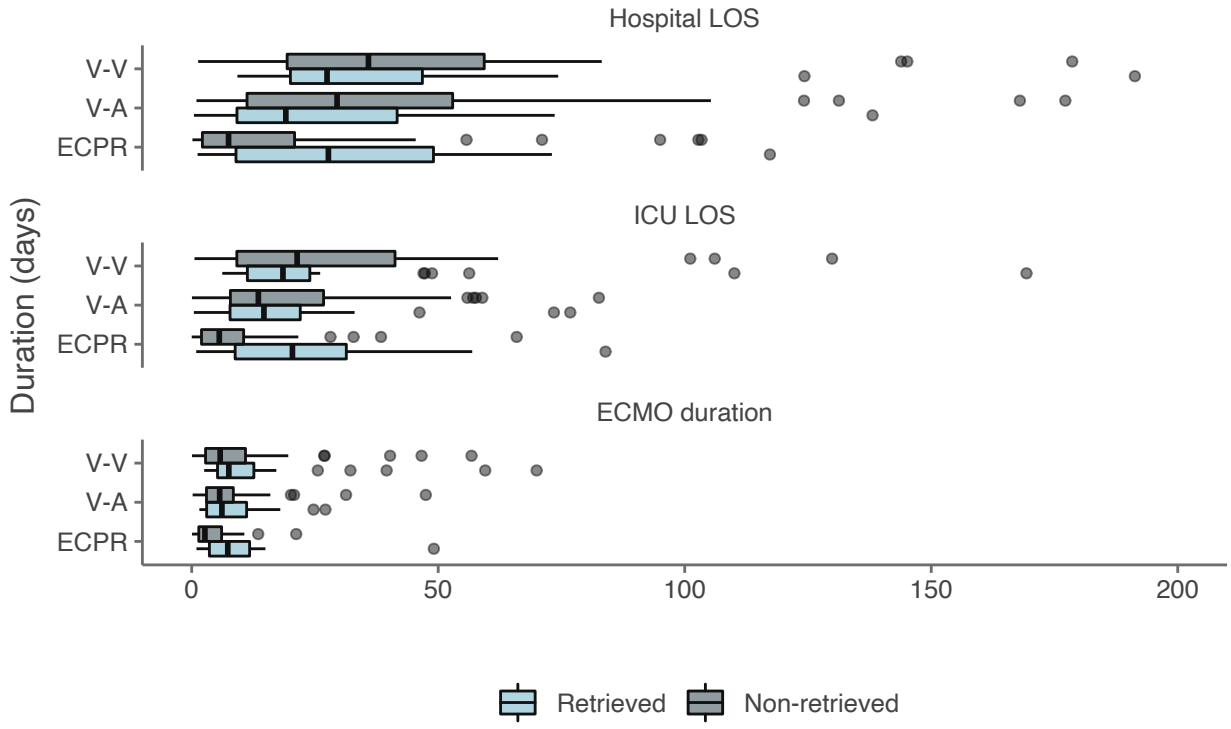


Figure 6: Distribution of length of stay stratified by transfer status

For the sake of clarity, the following patients have been removed from the figures above:

- 1 Non-retrieved VV patient had an ICU LOS of 394.9 and a Hospital LOS of 472.1 days
- 1 Non-retrieved VV patient had an ICU LOS of 215.8 days and a Hospital LOS of 245.9 days
- 1 Non-retrieved VA patient had a Hospital LOS of 260 days

ECMO trips

Table 9: Number of trips stratified by ECMO type

	V-V (N=72)	V-A (N=146)	ECPR (N=58)	Total (N=276)
Number of operative theatre trips[1]				
Mean (SD)	1.3 (0.6)	2.6 (1.5)	2.1 (1.4)	2.1 (1.4)
Range	1.0 - 4.0	1.0 - 11.0	1.0 - 6.0	1.0 - 11.0
Missing	2	1	1	4
Number of radiology trips[1]				
Mean (SD)	2.5 (1.9)	2.1 (1.7)	2.6 (2.0)	2.3 (1.8)
Range	1.0 - 7.0	1.0 - 10.0	1.0 - 10.0	1.0 - 10.0
Missing	1	2	0	3

1. Trips occur when a patient is physically transferred to another location to facilitate imaging and/or procedure

ECMO discontinuation

Table 10: ECMO discontinuation reason stratified by ECMO type

	V-V (N=72)	V-A (N=146)	ECPR (N=58)	Total (N=276)
ECMO discontinuation reason				
Expected recovery	52 (73.2%)	86 (59.7%)	20 (35.1%)	158 (58.1%)
Poor prognosis	10 (14.1%)	27 (18.8%)	14 (24.6%)	51 (18.8%)
ECMO mortality	4 (5.6%)	18 (12.5%)	20 (35.1%)	42 (15.4%)
Bridge to VAD	1 (1.4%)	9 (6.2%)	0 (0.0%)	10 (3.7%)
Bridge to heart transplant	0 (0.0%)	3 (2.1%)	1 (1.8%)	4 (1.5%)
Bridge to lung transplant	2 (2.8%)	0 (0.0%)	0 (0.0%)	2 (0.7%)
Unknown	1 (1.4%)	0 (0.0%)	1 (1.8%)	2 (0.7%)
Resource limitation	1 (1.4%)	0 (0.0%)	0 (0.0%)	1 (0.4%)
Bridge to pumpless lung assist (PA to LA)	0 (0.0%)	0 (0.0%)	1 (1.8%)	1 (0.4%)
ECMO complication	0 (0.0%)	1 (0.7%)	0 (0.0%)	1 (0.4%)
Total	71	144	57	272
Missing	1	2	1	4

ICU therapies

Table 11: ICU therapies

	V-V (N=72)	V-A (N=146)	ECPR (N=58)
Second ECMO Run			
Yes	1 (1.4%)	3 (2.1%)	3 (5.3%)
No	70 (98.6%)	141 (97.9%)	54 (94.7%)
Missing	1	2	1
Renal Replacement Therapy			
Yes	30 (42.3%)	95 (65.5%)	38 (65.5%)
No	41 (57.7%)	50 (34.5%)	20 (34.5%)
Missing	1	1	0


Wards 5-6
Intensive Care Unit

COMPLICATIONS

Table 12: Proportion of patients with complications

Complications category	
Renal	78.7%
Cardiovascular	68.3%
Bleeding	52.6%
Infection	46.2%
Mechanical	18.9%
Neurological	16.9%
Pulmonary	10.8%

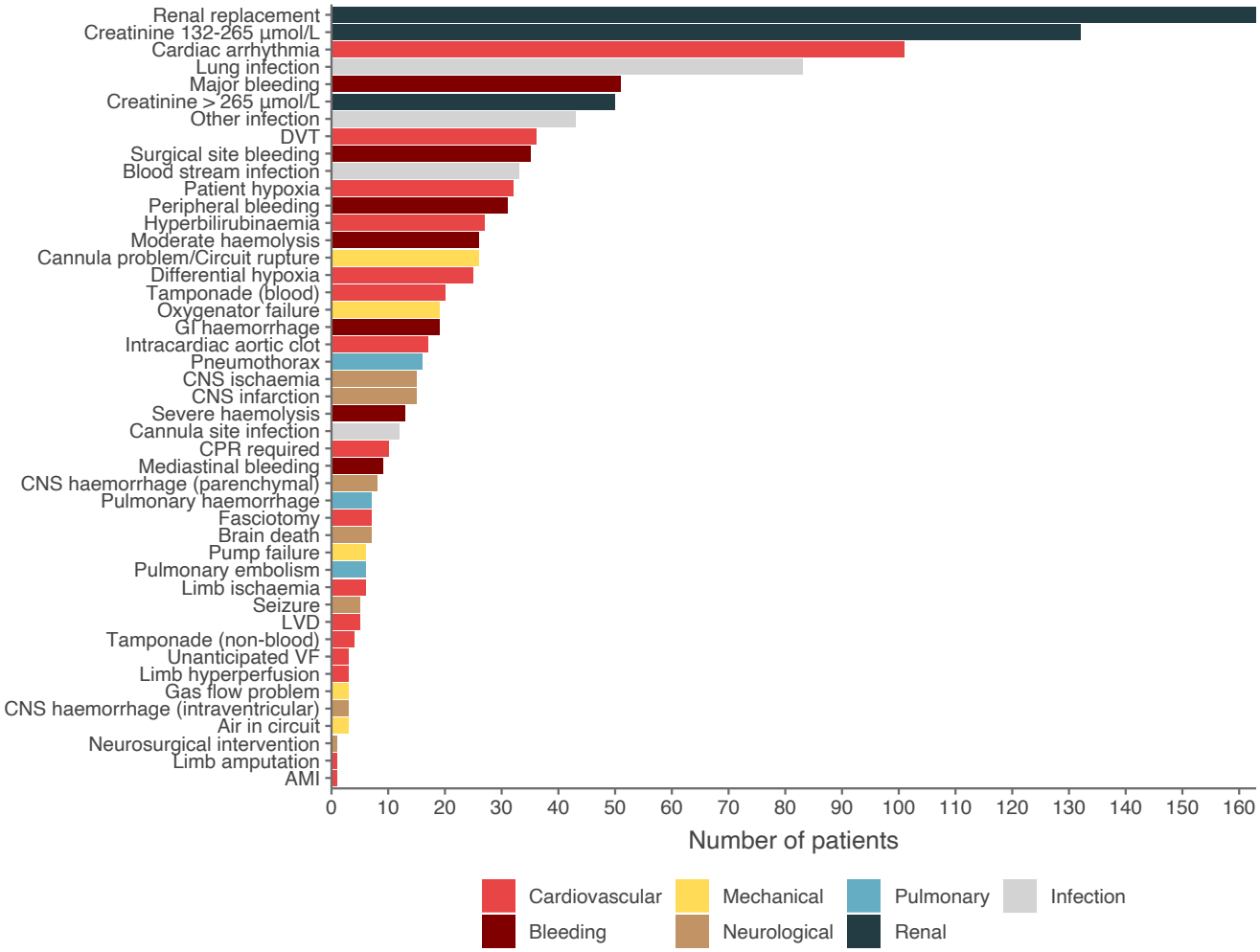


Figure 7: Distribution of post-ECMO complications

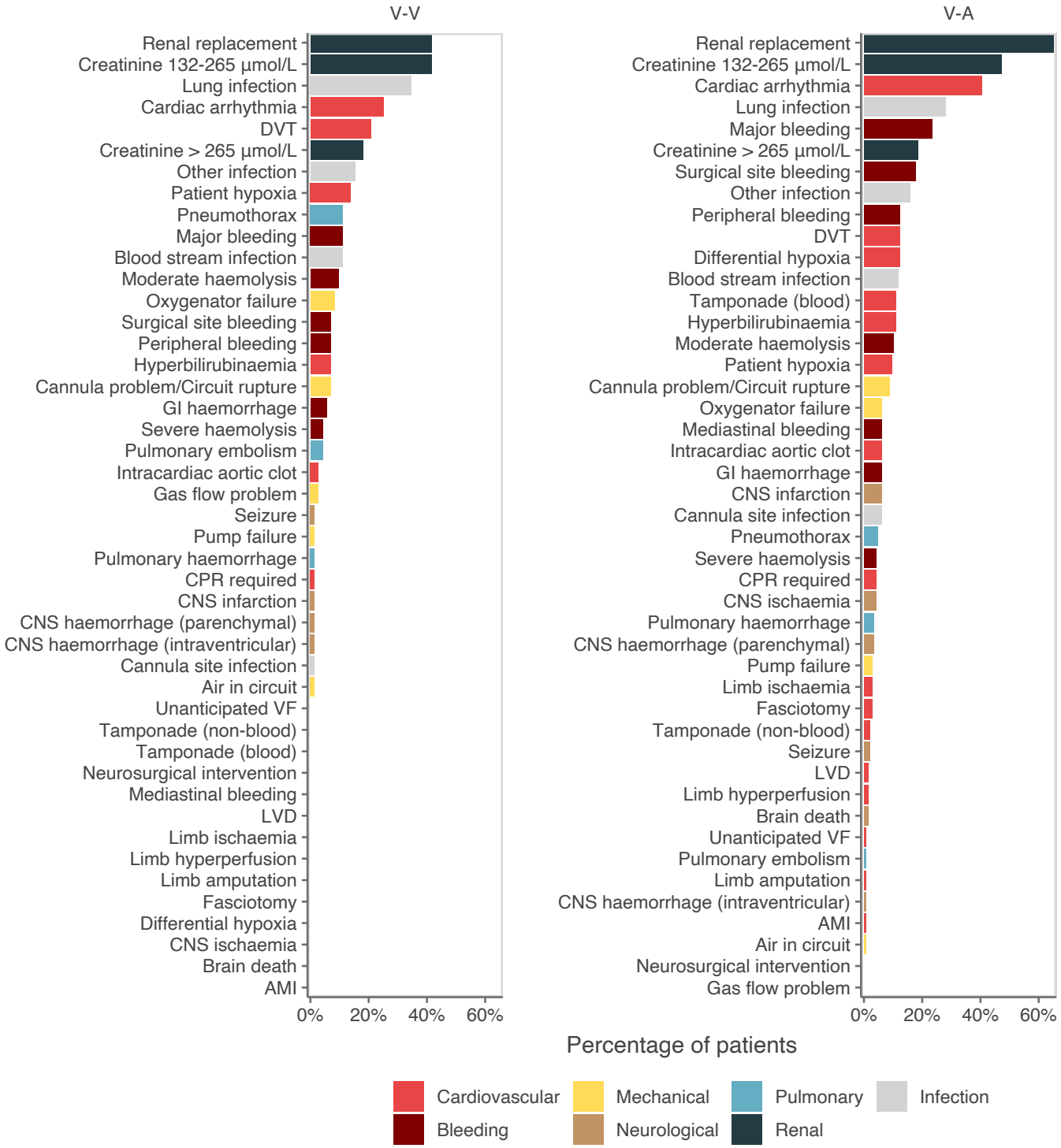


Figure 8: Distribution of post-ECMO complications stratified by ECMO mode (1/2)

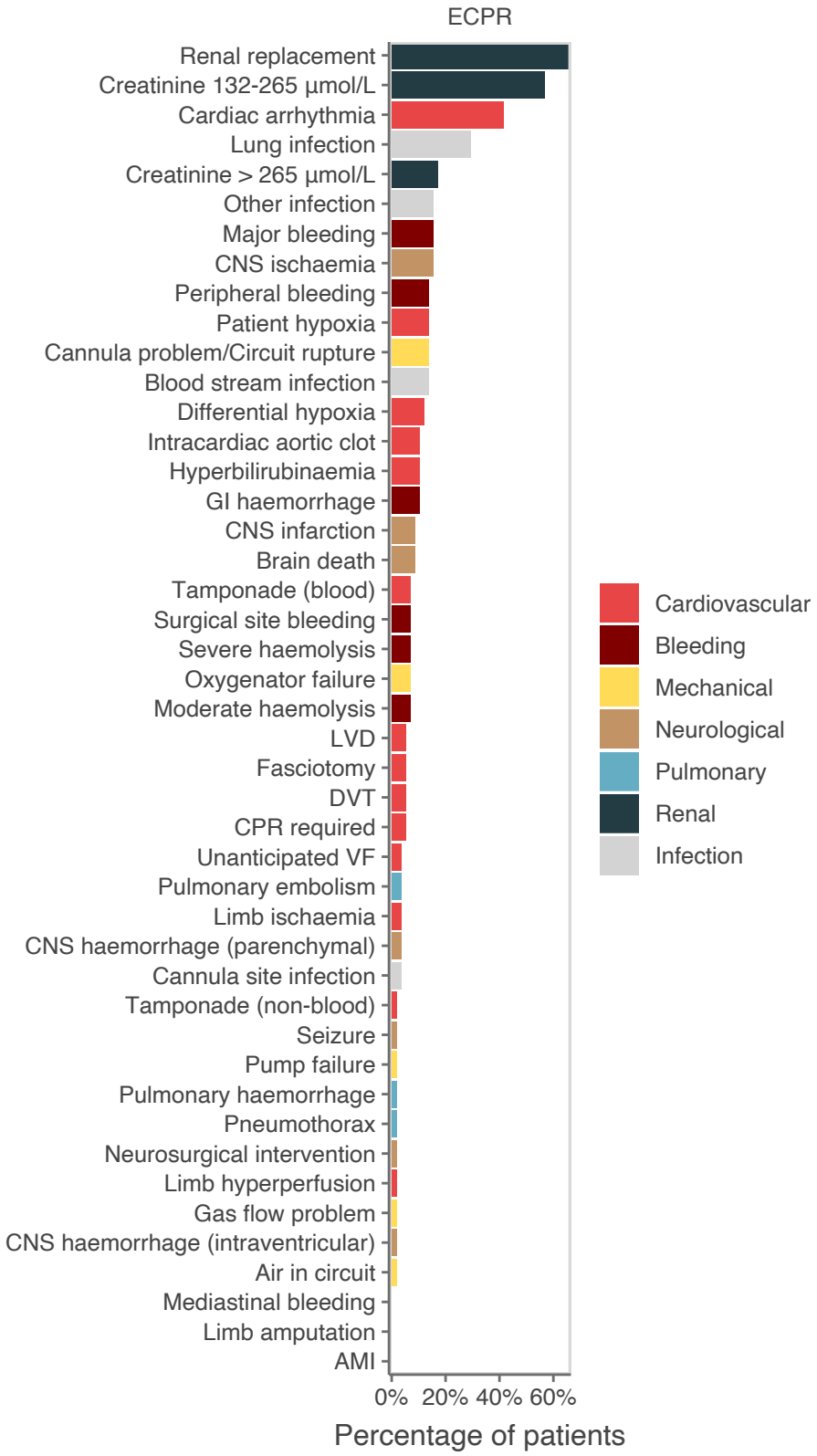


Figure 9: Distribution of post-ECMO complications stratified by ECMO mode (2/2)

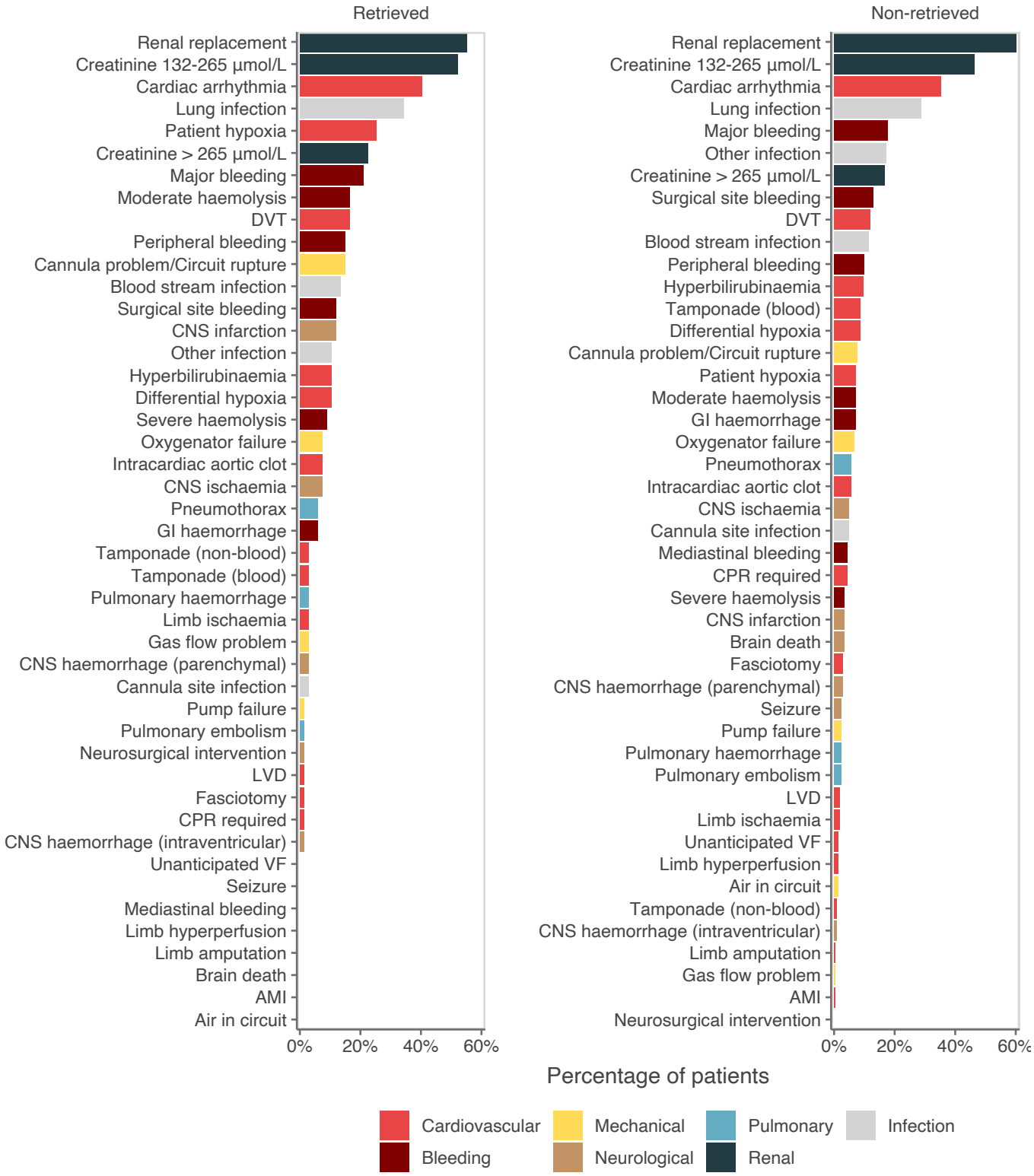


Figure 10: Distribution of post-ECMO complications stratified by transfer status

OUTCOME DATA

Proximate cause of death

Table 13: Proximate cause of death stratified by ECMO type

	V-V (N=72)	V-A (N=146)	ECPR (N=58)	Total (N=276)
Proximate cause of death				
Cardiogenic shock	0 (0.0%)	29 (46.0%)	15 (37.5%)	44 (37.0%)
Distributive (Septic) shock	3 (18.8%)	9 (14.3%)	4 (10.0%)	16 (13.4%)
Neurological no TBI without brain death	0 (0.0%)	9 (14.3%)	7 (17.5%)	16 (13.4%)
Other	1 (6.2%)	7 (11.1%)	5 (12.5%)	13 (10.9%)
Hypoxic respiratory failure	11 (68.8%)	0 (0.0%)	0 (0.0%)	11 (9.2%)
Neurological no TBI with brain death	1 (6.2%)	2 (3.2%)	4 (10.0%)	7 (5.9%)
Arrhythmia	0 (0.0%)	3 (4.8%)	3 (7.5%)	6 (5.0%)
Metabolic	0 (0.0%)	3 (4.8%)	0 (0.0%)	3 (2.5%)
Hypovolaemic shock	0 (0.0%)	1 (1.6%)	1 (2.5%)	2 (1.7%)
Neurological TBI without brain death	0 (0.0%)	0 (0.0%)	1 (2.5%)	1 (0.8%)
Total	16	63	40	119

Discharge destination

Table 14: Discharge destination post-ECMO stratified by ECMO type

	V-V (N=72)	V-A (N=146)	ECPR (N=58)	Total (N=276)
ICU discharge destination				
Ward	46 (64.8%)	75 (51.7%)	16 (27.6%)	137 (50.0%)
Deceased	14 (19.7%)	60 (41.4%)	37 (63.8%)	111 (40.5%)
Other hospital ICU	9 (12.7%)	8 (5.5%)	4 (6.9%)	21 (7.7%)
Other	0 (0.0%)	2 (1.4%)	1 (1.7%)	3 (1.1%)
Other hospital- normal ward	2 (2.8%)	0 (0.0%)	0 (0.0%)	2 (0.7%)
Total	71	145	58	274
Missing	1	1	0	2
Hospital discharge destination				
Deceased’	16 (22.9%)	62 (43.1%)	40 (69.0%)	118 (43.4%)
Home	32 (45.7%)	39 (27.1%)	11 (19.0%)	82 (30.1%)
Transfer to rehab	8 (11.4%)	26 (18.1%)	3 (5.2%)	37 (13.6%)
Transferred to another hospital	14 (20.0%)	16 (11.1%)	4 (6.9%)	34 (12.5%)
Other	0 (0.0%)	1 (0.7%)	0 (0.0%)	1 (0.4%)
Total	70	144	58	272
Missing	2	2	0	4

30, 60, 90 and 180-day survival

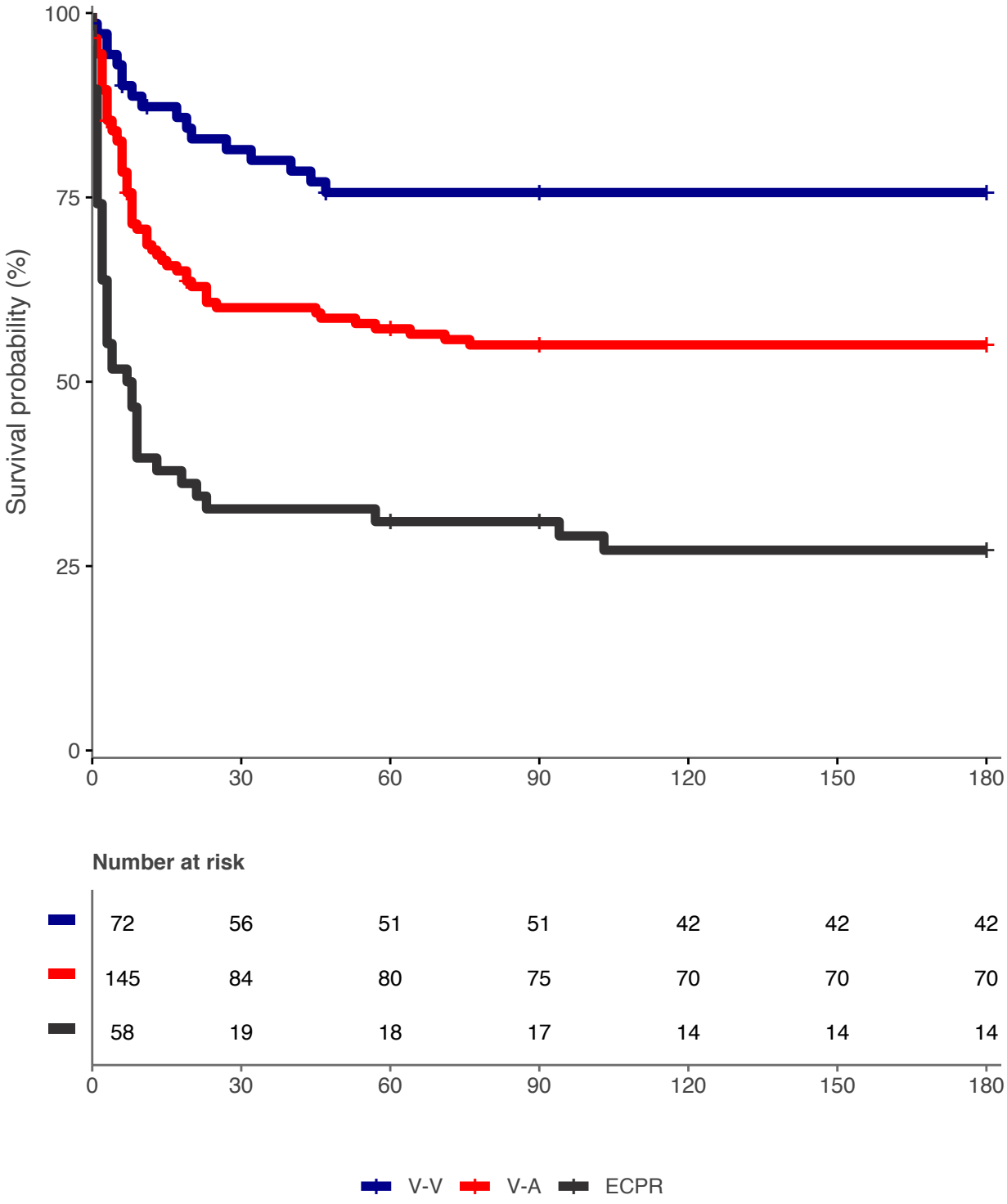


Figure 11: Kaplan-Meier plot of survival stratified by ECMO type

30, 60, 90 and 180-day survival stratified by transfer status and ECMO type

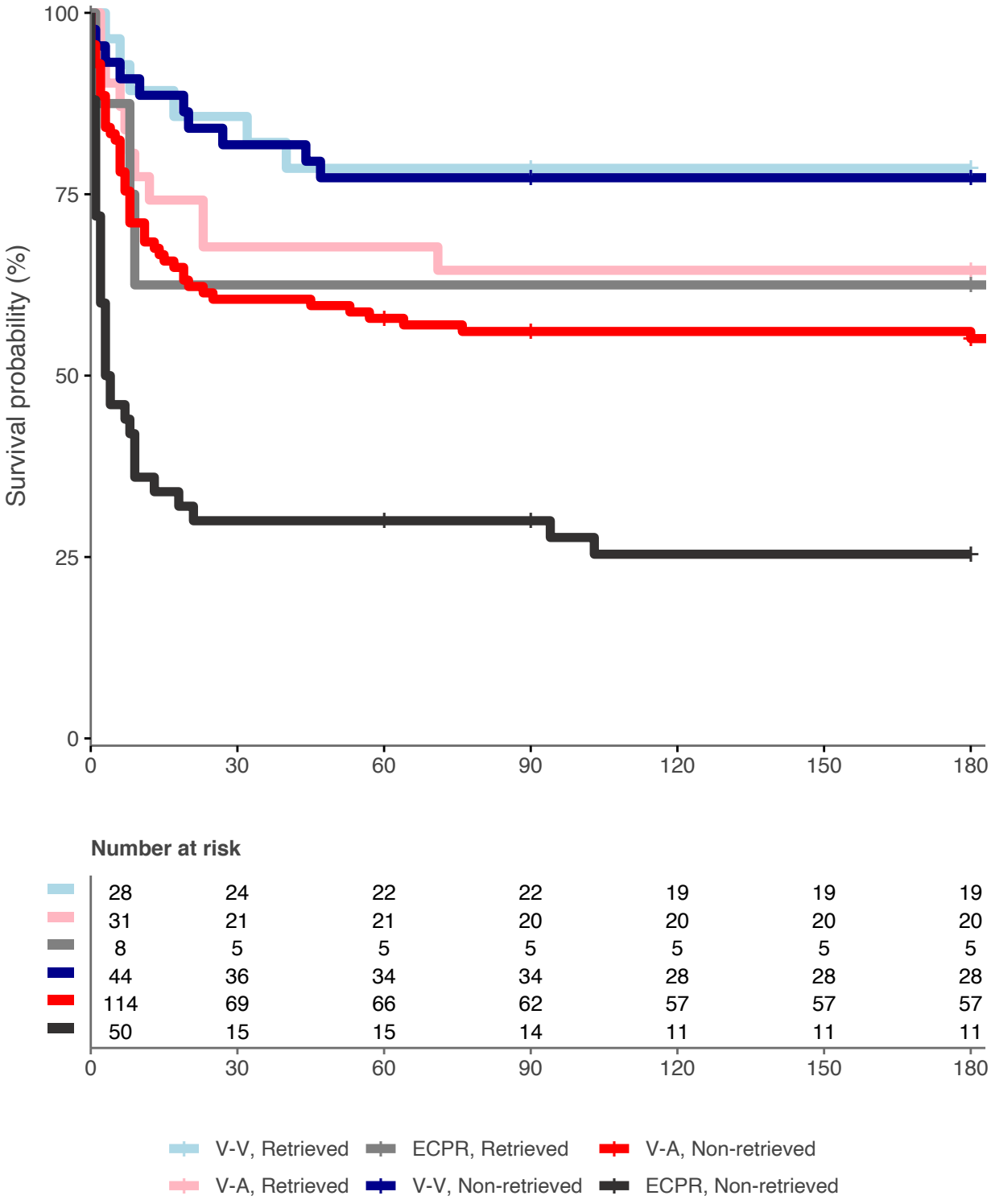


Figure 12: Kaplan-Meier plot of survival stratified by transfer status and ECMO type

Funnel plots

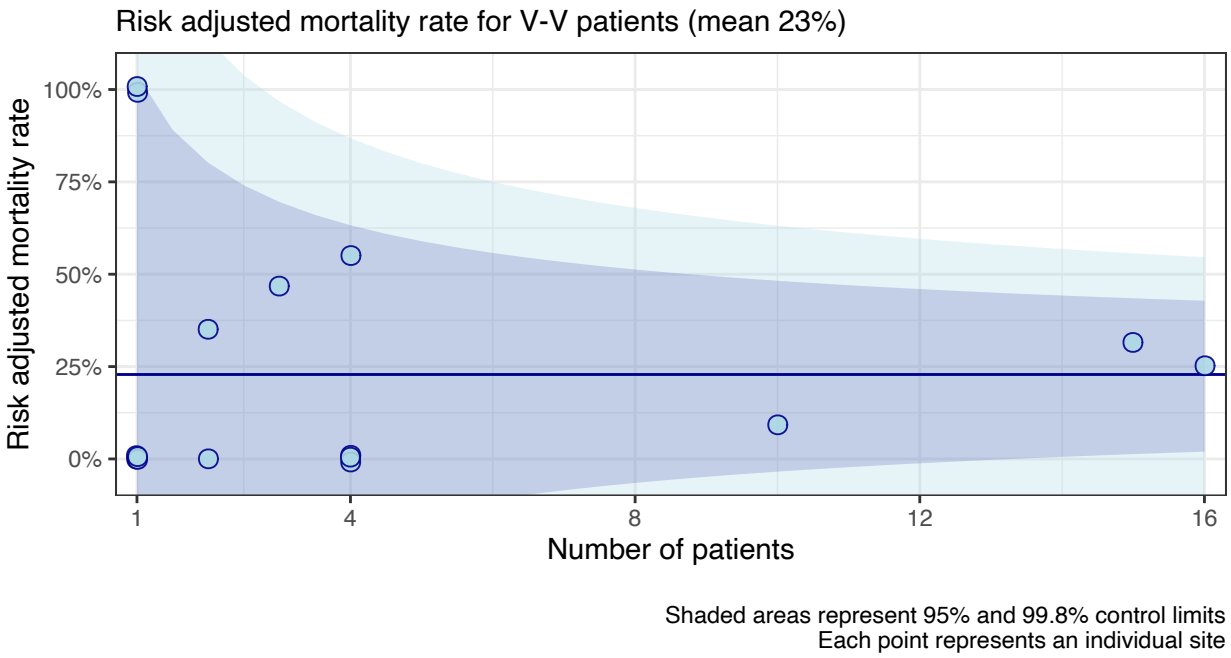


Figure 13: Risk adjusted mortality rate for V-V patients

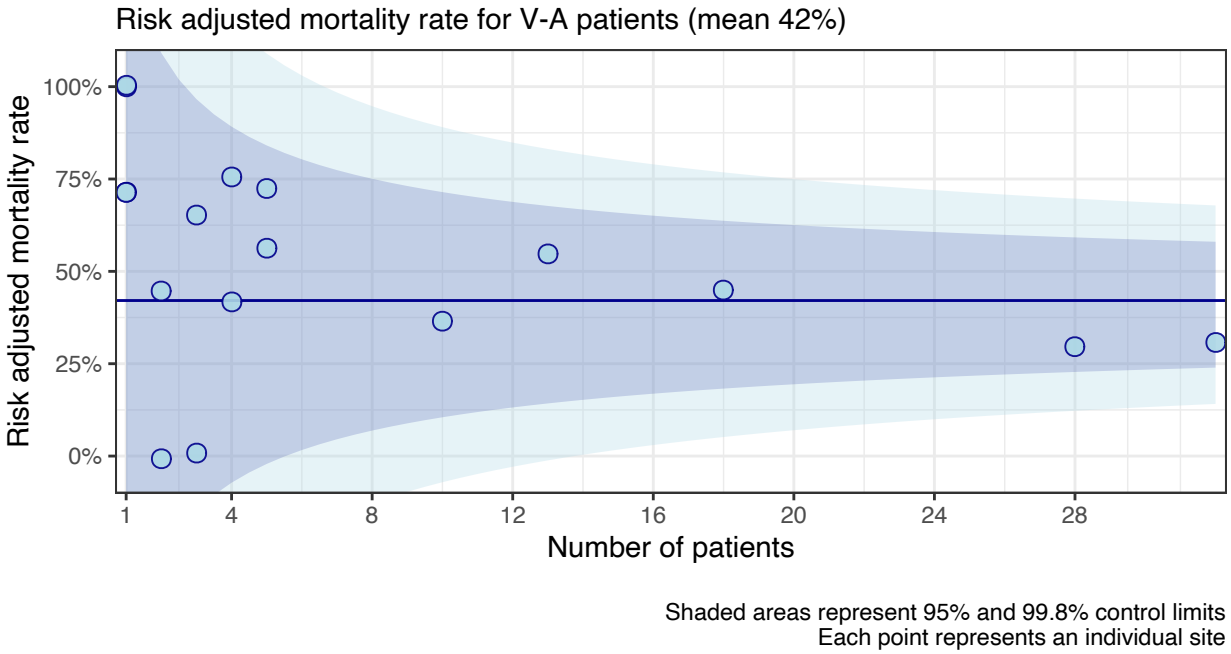


Figure 14: Risk adjusted mortality rate for V-A patients

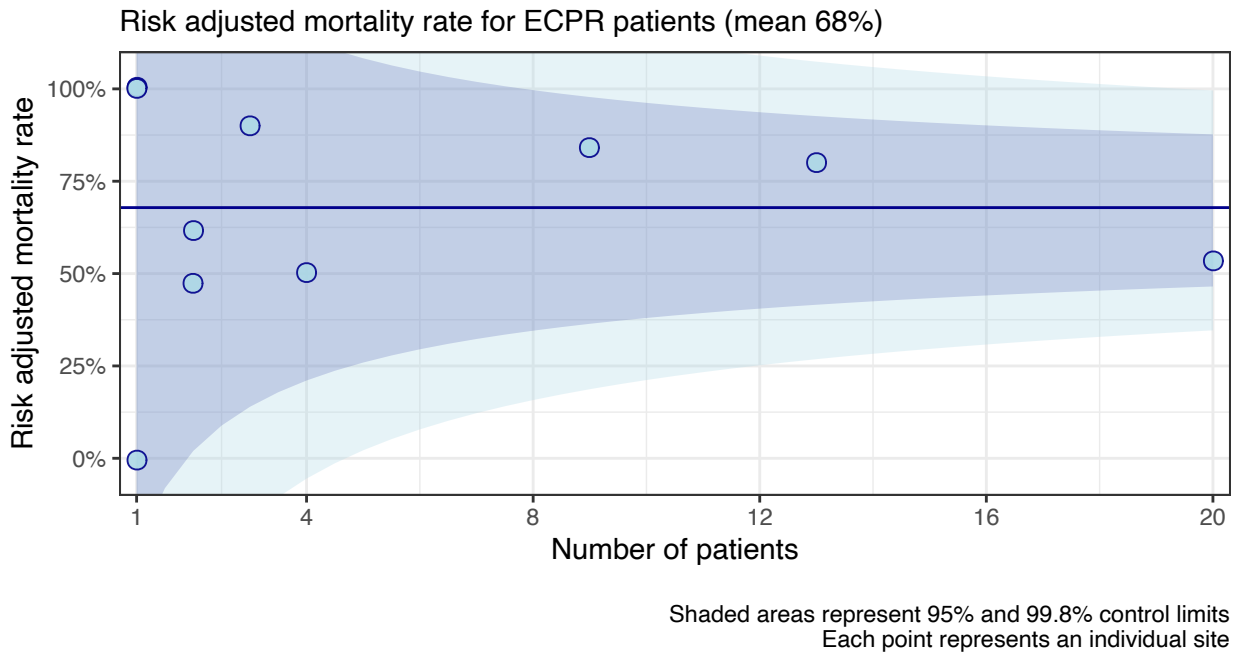


Figure 15: Risk adjusted mortality rate for ECPR patients

FOLLOW-UP (6 months post ECMO)

Distribution of 6-month follow-up functional outcome measures

Vertical lines illustrate 25th, 50th, and 75th percentiles

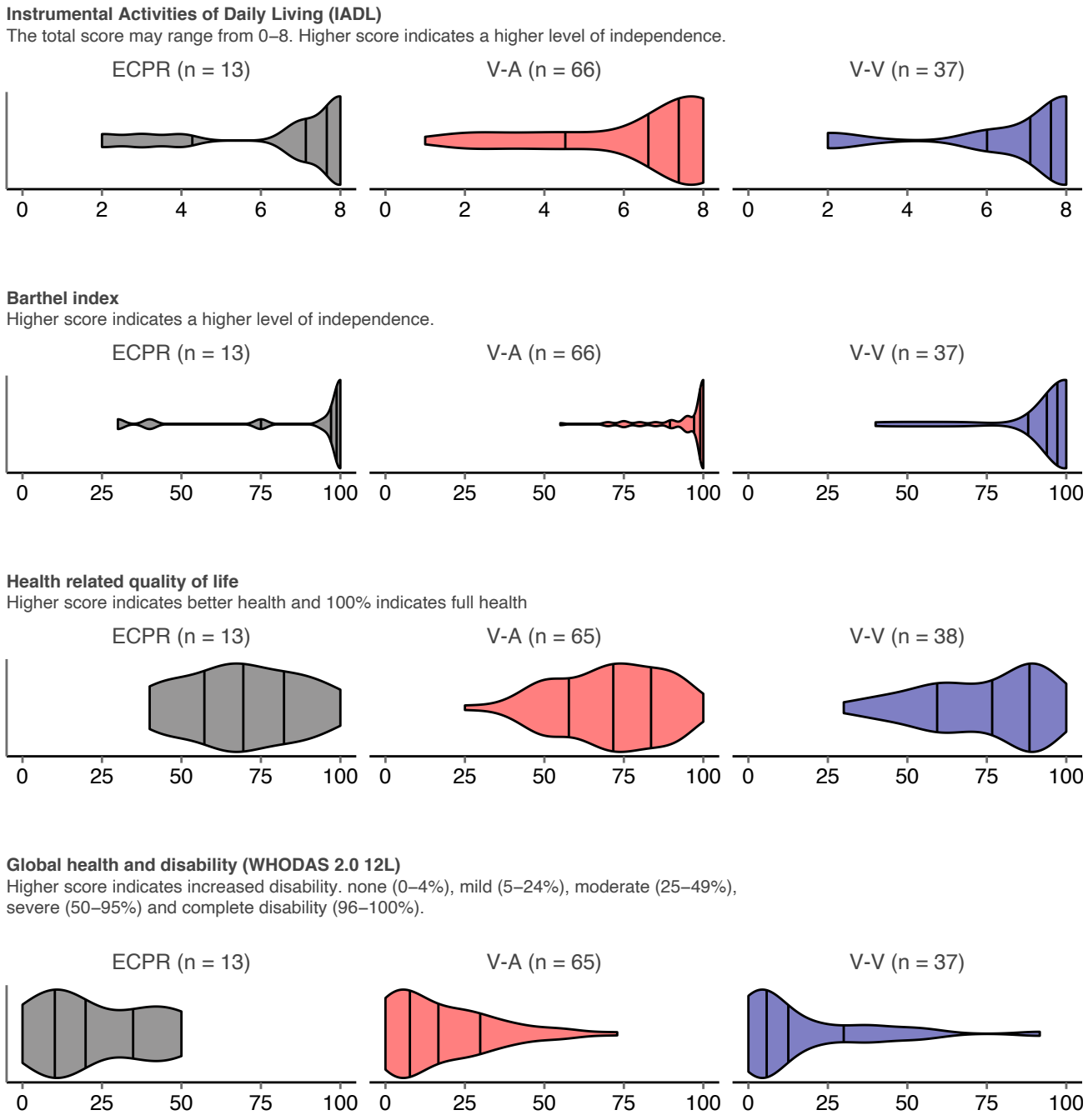


Figure 16: Distribution of follow-up functional outcome measures by site and ECMO mode

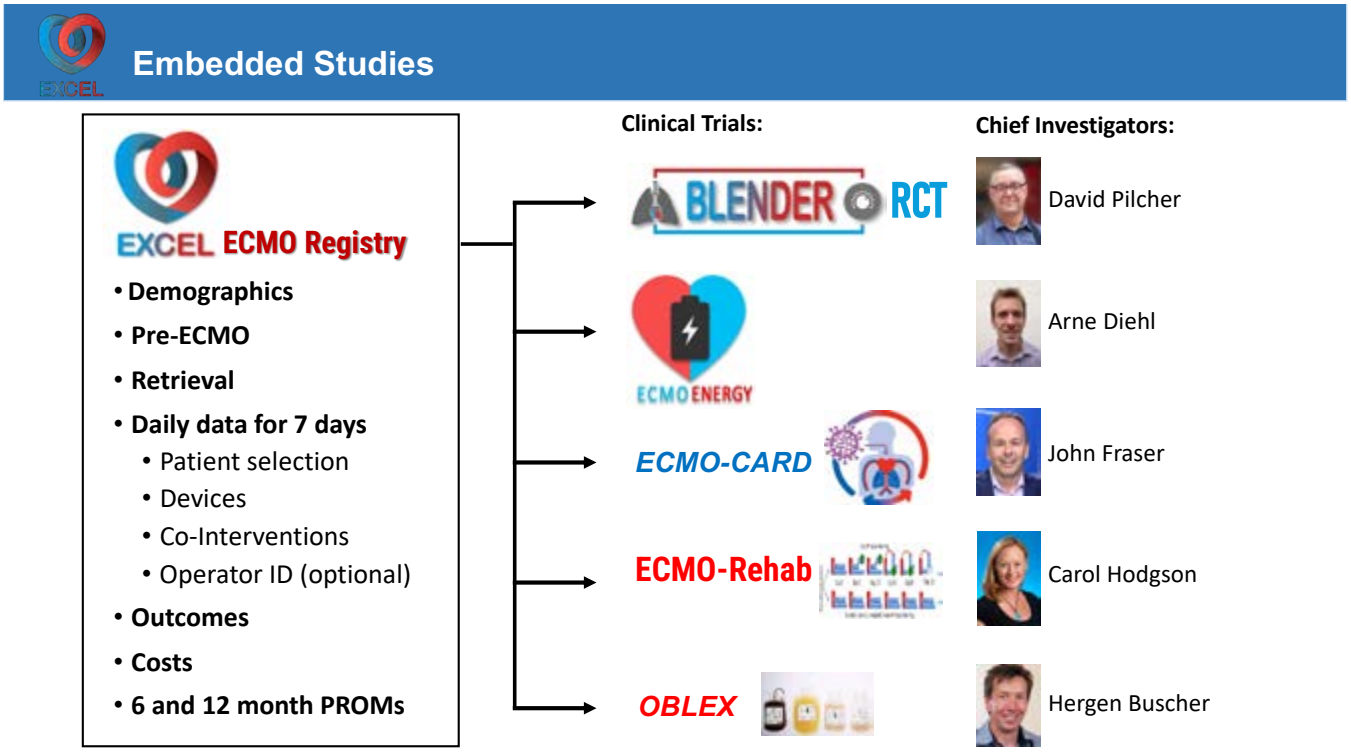
FUTURE INITIATIVES

As the EXCEL Registry moves towards maturity, the data are becoming more valuable for monitoring ECMO in Australia. We will be undertaking further work on testing and refining algorithms to identify outliers, device performance, safety signals, risk prediction and patient outcomes.

We anticipate that data from the EXCEL Registry will become increasingly important to drive continuous quality improvement in healthcare. We plan more detailed reports back to sites and funders including their choice of process measures of care. We will continue to work with stakeholders, including consumers, to raise awareness about the registry within Australia. This report is designed to provide feedback to Australian and New Zealand ECMO sites about patient outcomes and to inform healthcare providers about the national use and outcomes of ECMO.

We have been fortunate to receive partnership funding from the NHMRC, Heart Foundation, the International ECMO Network, The Dicker Family, Critical Care Research Group (CCRG), and major Australian ECMO sites including The Prince Charles Hospital, The Alfred, St Vincent's Hospital Sydney, The University Hospital Geelong, and Royal Prince Alfred Hospital. We will be exploring alternate funding models within the Commonwealth, and look forward to engaging with stakeholders to measure and report on new models of care.

The EXCEL Registry will continue to work with our research collaborators, including the existing studies that are embedded within the registry:



We have four completed publications (see below) and several planned publications on retrievals, decannulation, long term outcomes and costs. We have presented our data at The World Congress of Intensive Care (2019) and the ANZICS Conference on Safety and Quality (2019). Work is also being done with the INDEX Registry in North America, and a planned annual report may eventuate.

On behalf of the EXCEL Management Committee, we look forward to another active year ahead, working with clinicians, hospitals, patients and other stakeholders to improve the health of Australians on ECMO.

PUBLICATIONS

1. Linke NJ, Fulcher BJ, Engeler DM, et al; EXCEL Investigators. A survey of extracorporeal membrane oxygenation practice in 23 Australian adult intensive care units. Crit Care Resusc 2020;22(2):166-70. PMID: 32389109
2. Fulcher BJ, Nicholson AJ, Linke NJ, Berkovic D, Hodgson CL; EXCEL Study Investigators and the International ECMO Network. The perceived barriers and facilitators to implementation of ECMO services in acute hospitals. Intensive Care Med. 2020;46(11):2115-7. PMID: 32705292
3. Hodgson CL, Burrell AJC, Engeler DM, Pellegrino VA, Brodie D, Fan E, International ECMO Network. Core Outcome Measures for Research in Critically Ill Patients Receiving Extracorporeal Membrane Oxygenation for Acute Respiratory or Cardiac Failure: An International, Multidisciplinary, Modified Delphi Consensus Study. Crit Care Med 2019;47(11):1557-63. PMID: 31389837
4. ECMO-PT Study Investigators; International ECMO Network. Early mobilisation during extracorporeal membrane oxygenation was safe and feasible: a pilot randomised controlled trial. Intensive Care Med 2020;46(5):1057-9. PMID: 32179935