ECLS in Severe ARDS Secondary to Covid-19 Pneumonia COVID: Lessons Learned What worked and what didn't work?

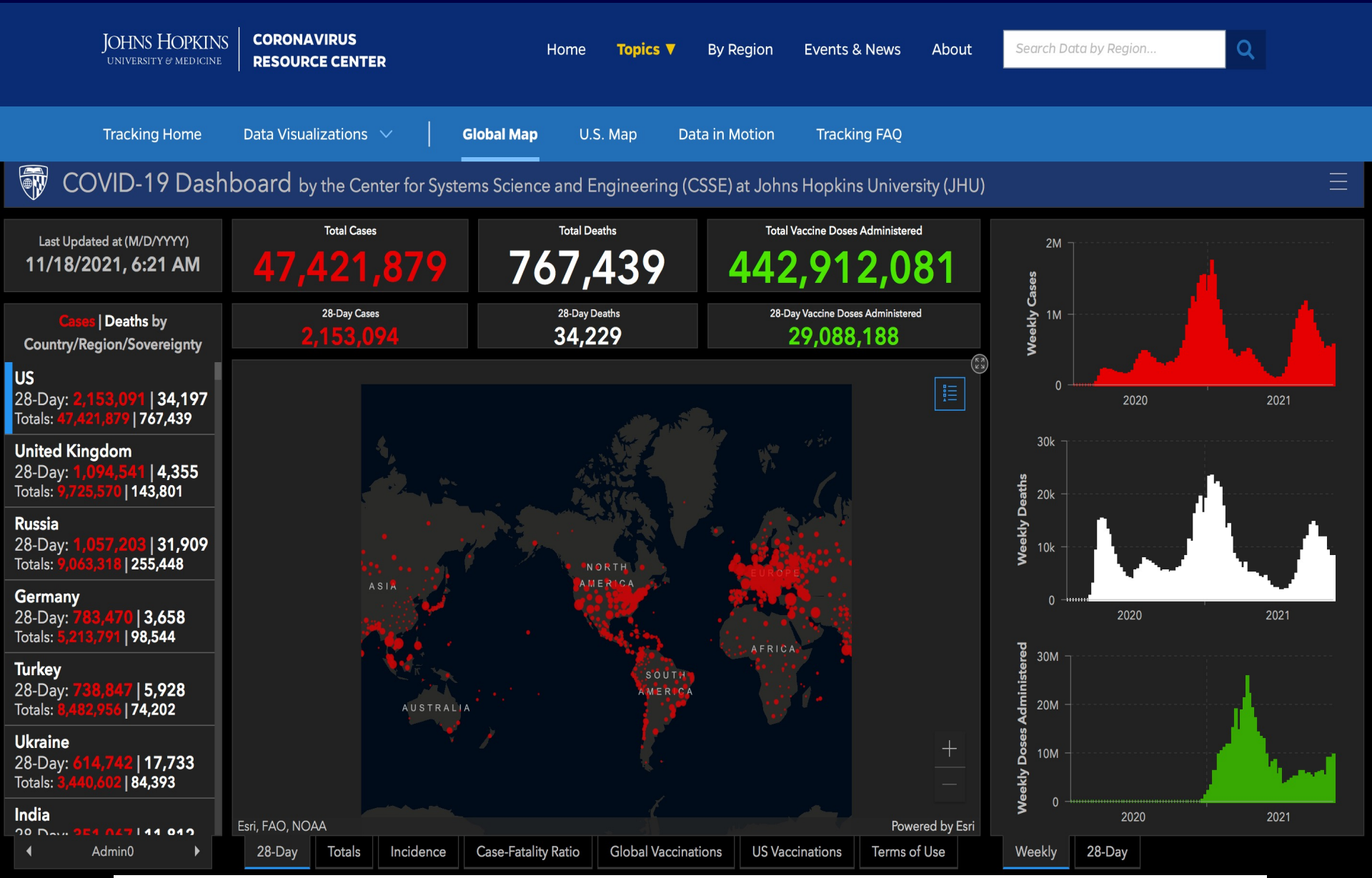
Aly El Banayosy, MD
Medical Chief Mechanical Circulatory Support and Specialty Critical Care

INTEGRIS Baptist Medical Center OKC, OK

Disclosures

Abbott	Investigator
Syncardia	MAB
M3	MAB
Fresenius	MAB

COVID-19 Snapshot



https://coronavirus.jhu.edu/map.html. Accessed Nov. 17, 2021.

New Admissions of Patients with Confirmed COVID-19, United States

Aug 01, 2020 - Nov 16, 2021

3,331,715
Total Admissions
Aug 01, 2020 - Nov 16, 2021

5,456
Current 7-Day Average
Nov 10, 2021 - Nov 16, 2021

5,176
Prior 7-Day Average
Nov 03, 2021 - Nov 09, 2021

16,478
Peak 7-Day Average
Jan 03, 2021 - Jan 09, 2021

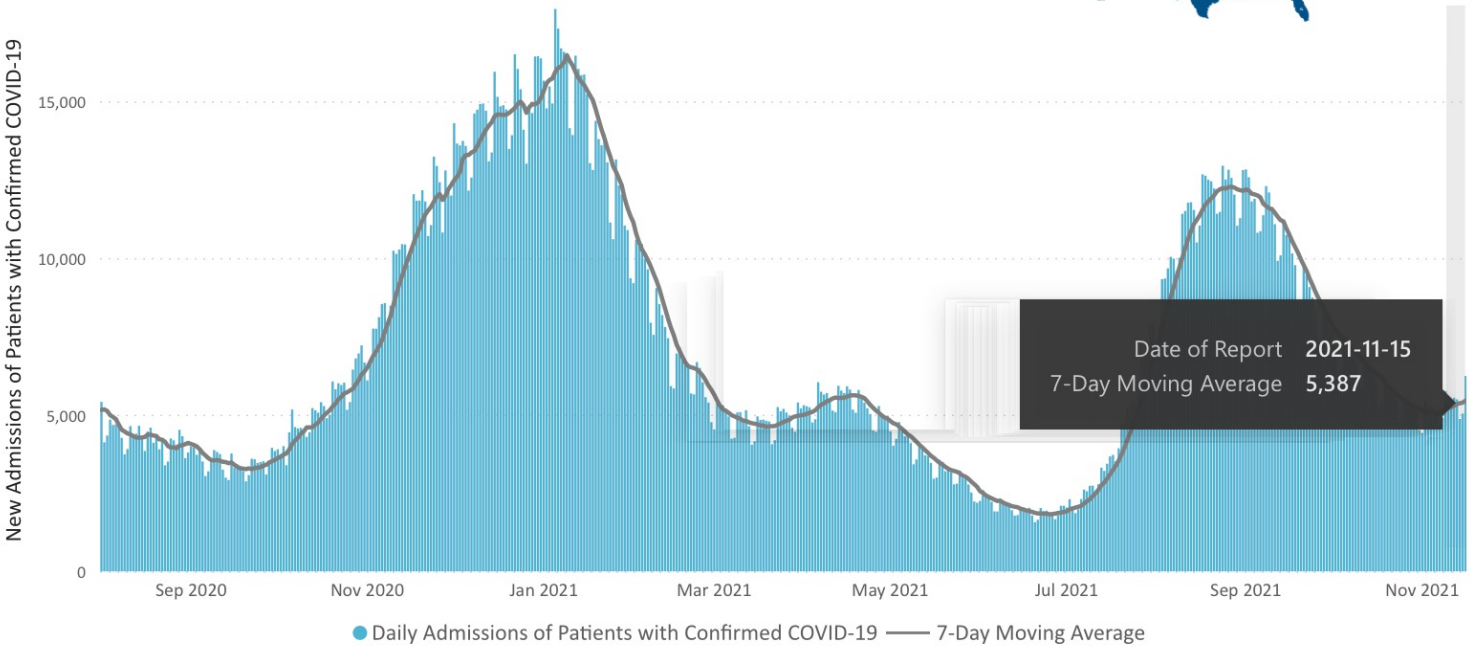
+5.4%
Percent change from prior 7-day avg. of Nov 03, 2021 - Nov 09, 2021

-66.9%
Percent change from peak 7-day avg. of Jan 03, 2021 - Jan 09, 2021

By Jurisdiction and Age Group | By Jurisdiction

Select a Jurisdiction: United States

HHS Regions



Based on reporting from all hospitals (N=5,258). Due to potential reporting delays, data reported in the most recent 7 days (as represented by the shaded bar) should be interpreted with caution.
Small shifts in historic data may occur due to changes in the CMS Provider of Services file, which is used to identify the cohort of included hospitals. Data since December 1, 2020 have had error correction methodology applied. Data prior to this date may have anomalies that are still being resolved. Data prior to August 1, 2020 are unavailable.

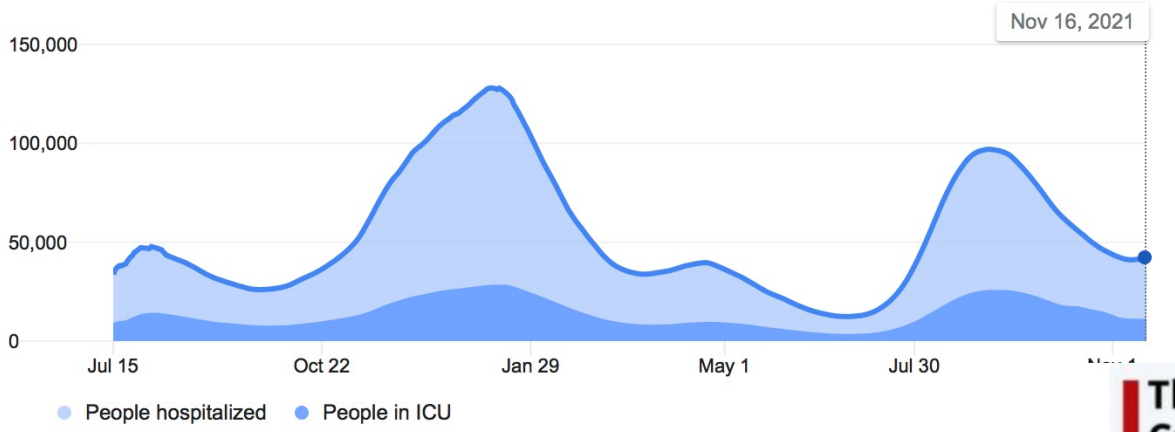
Last Updated: Nov 18, 2021

Unified Hospital Dataset, White House COVID-19 Team, Data Strategy and Execution Workgroup

Hospitalizations

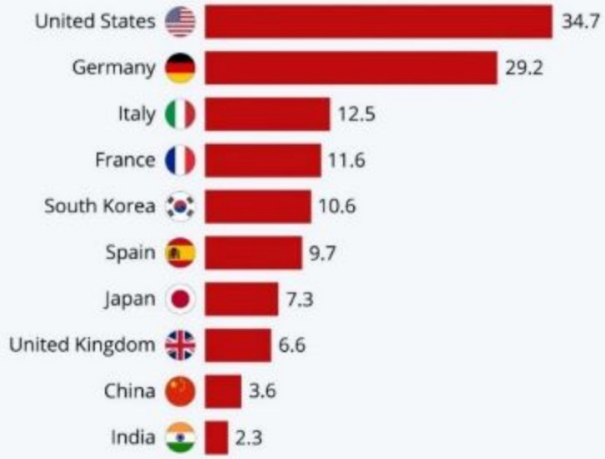
From Our World in Data · Last updated: 15 hours ago · Based on 7-day average

United States | All time



The Countries With The Most Critical Care Beds Per Capita

Total number of critical care beds per 100,000 inhabitants in selected countries*



* Most recent U.S. and EU data from 2009 and 2012 respectively. Asian data is from 2017.

Sources: National Center for Biotechnology Information, Intensive Care Medicine (journal), Critical Care Medicine (journal)

statista

COVID-19 Snapshot - USA

- Total cases: > 47 Mi. JHU
- Deaths: > 700,000 (1.5%) JHU
- Total hospital admissions: > 3 Mi. (Aug 01.20-Nov.17.21) CDC
- 20%-30% from hospitalized patients required ICU admission
- Total number of staffed hospital beds: 919,000 AHA
- Critical care beds: 110,000 AHA

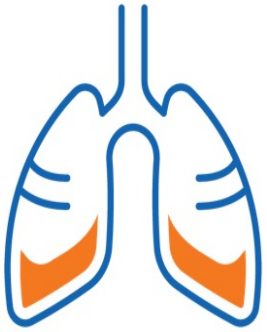
Management Approaches

- Many patients with COVID-19 do not require hospitalization[1]
- Severe cases often require patient hospitalization and ICU management[1]
- Approximately 15-30% of patients with COVID-19 develop ARDS[2]
  - May be refractory to conventional approaches
- Conventional approaches[1]
  - High-flow oxygen
  - Mechanical ventilation
  - Prone positioning
- Additional treatment approaches may be required when conventional management is not adequate[2]

[1]Lorusso R, et al. Intensive Care Med. 2021;47(3):344-8.

[2]Huang S, et al. BMC Pulm Med. 2021;21:116.

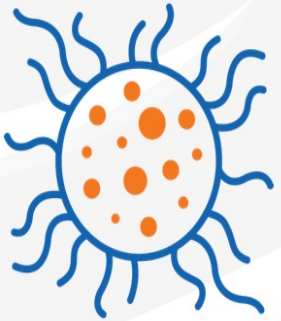
Covid-19 Disease: Challenges



Progressive hypoxemic respiratory failure

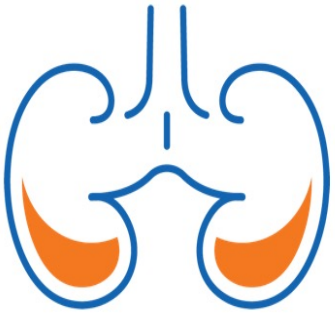
Hypercoagulability/ Pulmonary embolism

Cardiac injury/ toxicity



Immune abnormalities

Stroke

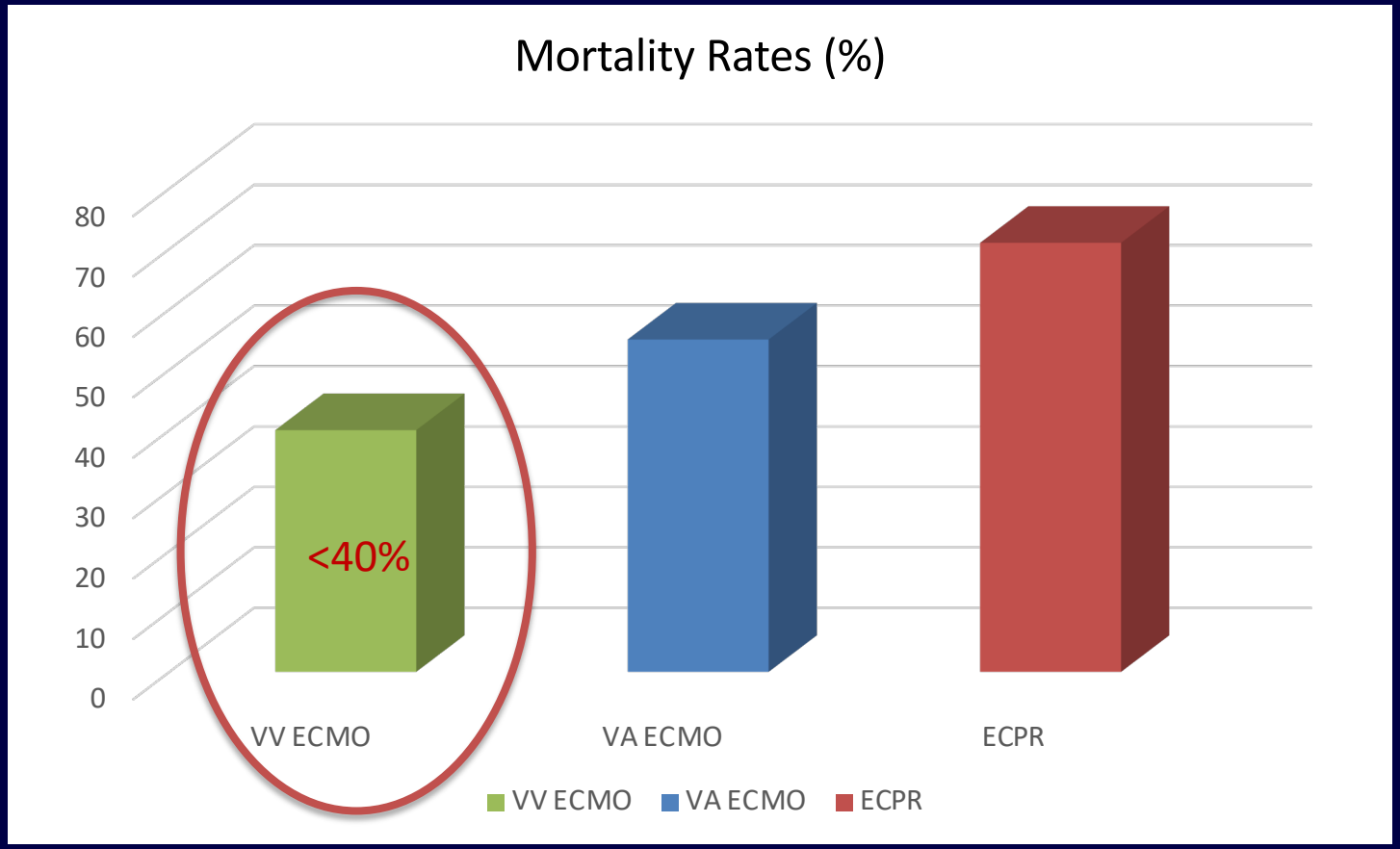


AKI

Hepatic dysfunction

[1]Huang S, et al. BMC Pulm Med. 2021;21:116.

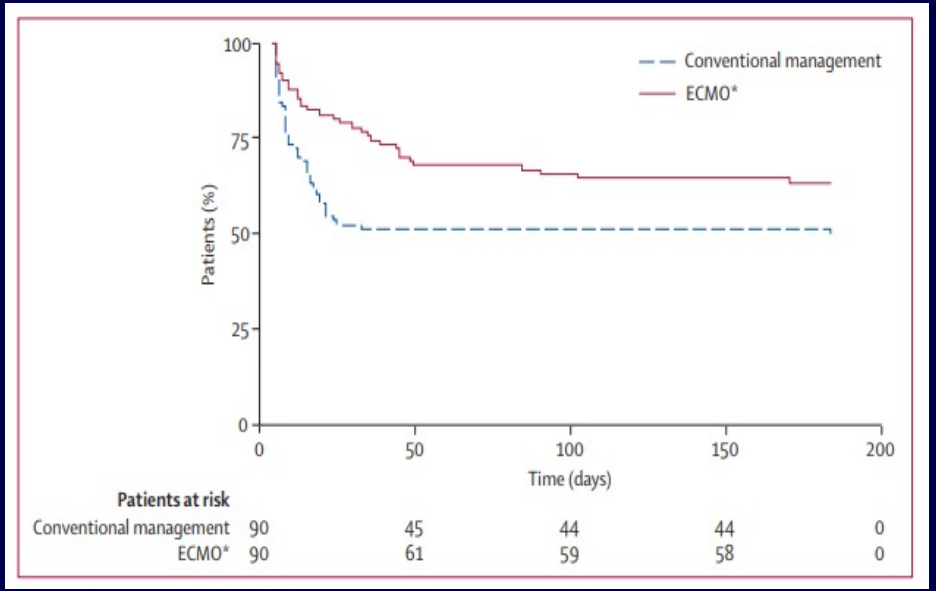
Pre-Pandemic ECMO Utilization in Severe ARDS Outcomes



- Badulak J, et al. ASAIO Journal. February 26, 2021.

CESAR Study

- Multicenter randomized controlled trial comparing ECMO with conventional management for severe ARDS*
  - 90 patients randomized to consideration of ECMO (68 actually received)
    - 63% (57/90) of these patients achieved 6-month survival without disability
  - 90 patients randomized to conventional management
    - 47% (41/87) of these patients achieved 6-month survival without disability
  - No standardized protocol in conventional management group



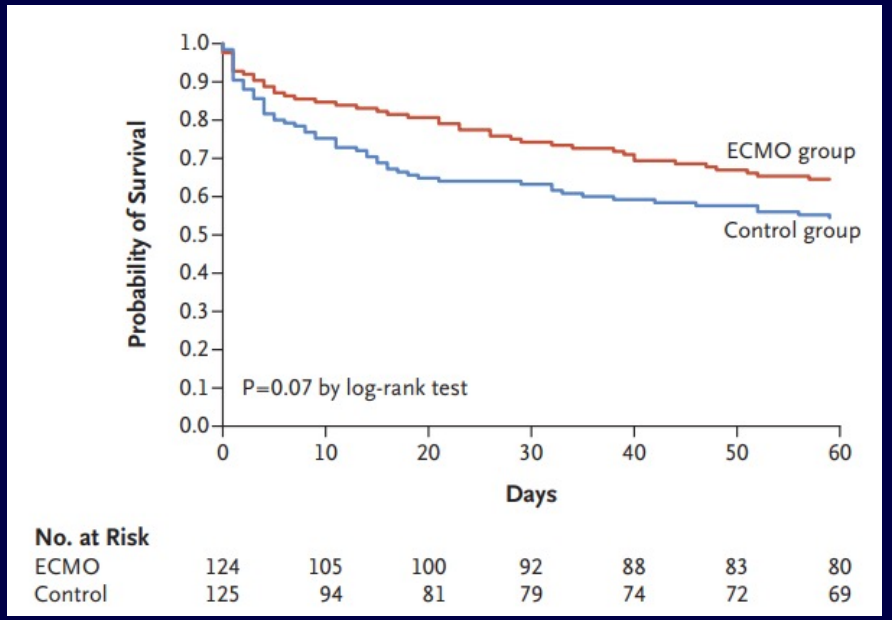
Kaplan-Meier Survival Estimates

*Murray score >3.0 or pH <7.20

Peek GJ, et al. Lancet. 2009;374(9698):1351-63.

EOLIA Study

- Landmark study of ECMO for the management of patients with ARDS
- 249 patients randomized (124 to ECMO group, 125 to control group)
  - ***60-day mortality was 35% for patients in ECMO group versus 46% with conventional management***
    - (RR 0.76, 95% CI 0.55-1.04, *P* = 0.09)
  - HR for death within 60 days (ECMO compared with control group)
    - 0.70 (95% CI 0.47-1.04, *P* = 0.07)
  - Limitations:
    - Stopped before reaching maximum sample size
    - 28% crossover rate in control group
    - Patient population from ECMO centers and non-ECMO centers
    - Likely underpowered for assessment of mortality 20% lower in ECMO group than in conventional group



Combes A, et al. N Engl J Med. 2018;378:1965-75.

Early Experience from Wuhan, China

- 52 patients with COVID-19[1]
  - 37 patients had mechanical ventilation
    - 7 survivors
  - 6 patients had ECMO
    - 1 survivor
  - Limitations: small cohort, retrospective study, some ICU data incomplete
- 191 patients with COVID-19[2]
  - 26 patients had non-invasive mechanical ventilation
    - 2 survivors
  - 32 patients had invasive mechanical ventilation
    - 1 survivor
  - 3 patients had ECMO
    - 0 survivors
  - Limitations: retrospective study, some patients transferred late in course of illness, limited estimation of viral shedding duration, case fatality ratio does not reflect true mortality of COVID, limited sample size

Yang X, et al. Lancet Respir Med. 2020;8(5):475-81.
Zhou F, et al. Lancet. 2020;395(10229):1054-62.

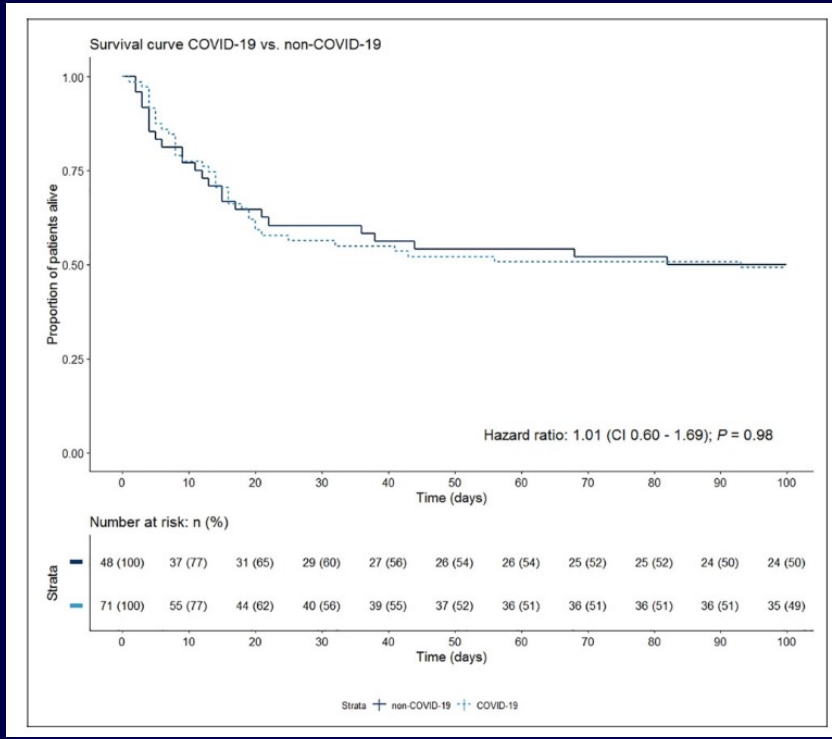
French Experience

- Multicenter retrospective study of ECMO in 83 patients with severe COVID-19 related ARDS
  - 34 patients returned to home
  - 14 patients hospitalized/in rehab out of ICU
  - 4 patients in ICU and off ECMO
  - 1 patient still on ECMO
  - 30 deaths
- ***Estimated probability of 60-day mortality: 31%***
- Baseline mean PaO_2/FiO_2 ratio of 62 mmHg was lower than EOLIA or LIFEGARD
- Limitations: patients treated in high-volume ECMO center, limited outcomes and other data collection, possible selection/information bias with limited cohort, lack of comparison with patients not treated with ECMO

Schmidt M, et al. Lancet Respir Med. 2020;8(11):1121-31.

ETALON Study

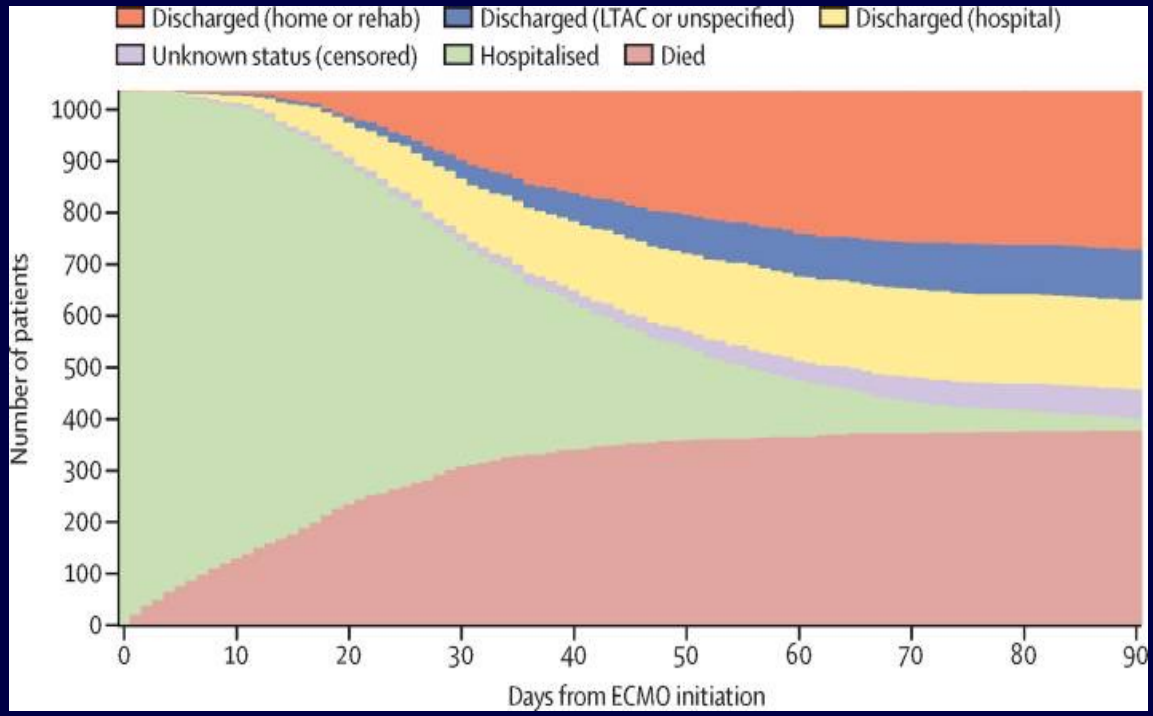
- Retrospective study of ECMO outcomes in patients with refractory ARDS
  - 71 with COVID-19
  - 48 without COVID-19
- ***28-day mortality in patients with COVID-19: 37%***
  - ***27% in patients without COVID-19***
  - Not statistically significant
  - Difference resolved at 100-day mark
- Authors concluded ECMO could be considered in supportive role for patients with refractory COVID-19 associated ARDS
- Limitations: observational nature of study, different time frames for patients with and without COVID on ECMO (possible variation in levels of care), lack of functional outcome data



Raasveld SJ, et al. J Intensive Care Med. 2021 Apr

ELSO Registry Study

- Incorporated international data from 1035 patients with COVID-19 who received ECMO[1]
  - ***For patients with ARDS: in-hospital mortality was 38.0%***
  - Estimated in-hospital mortality 90 days after starting ECMO: 37.4%
- Results comparable to earlier studies of ECMO for patients with ARDS who did not have COVID-19[1]



[1]Barbaro RP, et al. Lancet. 2020;396(10257):1071-8.

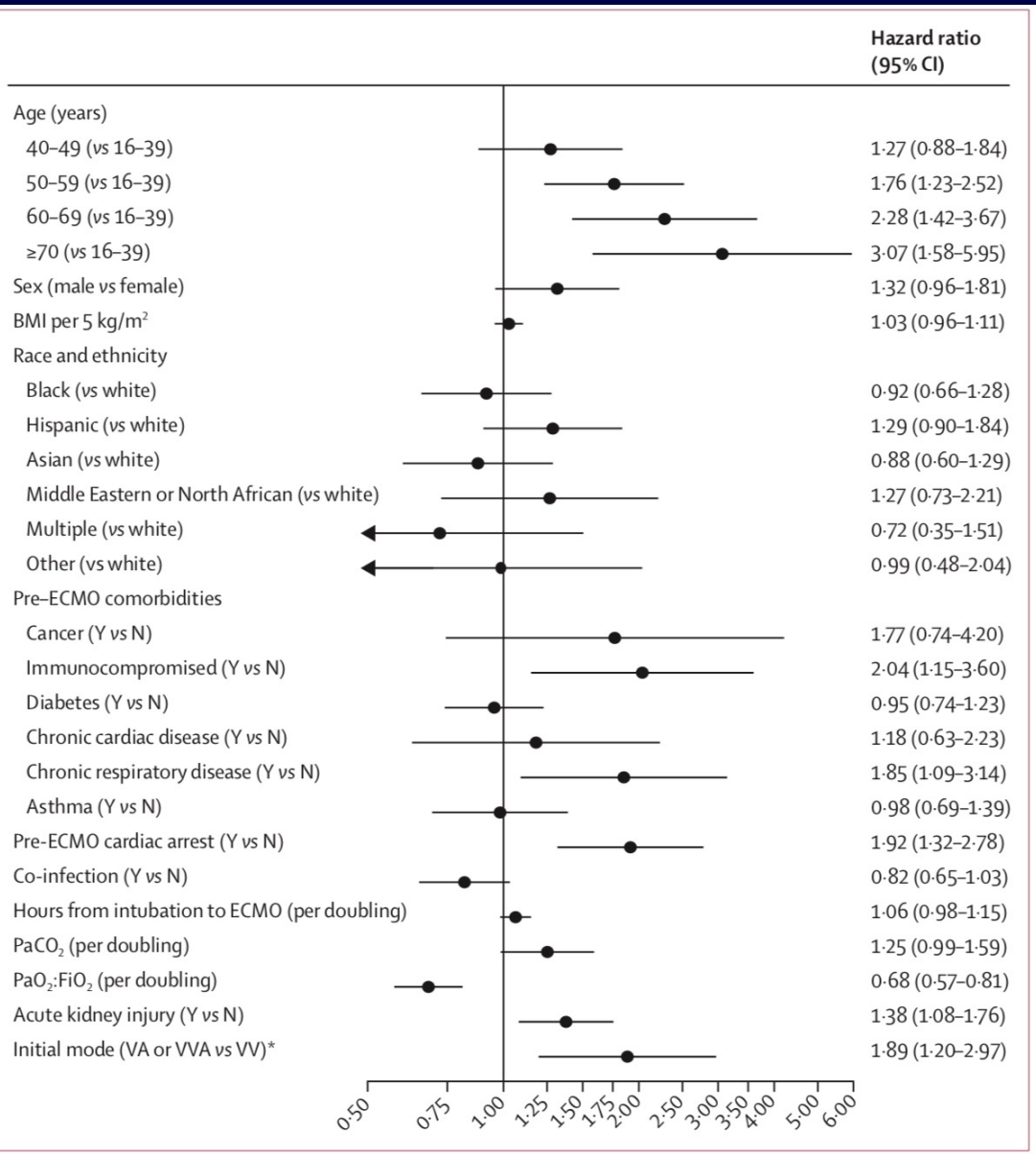


Figure 3: **Cox model for factors associated with in-hospital mortality in patients with COVID-19 supported with ECMO**

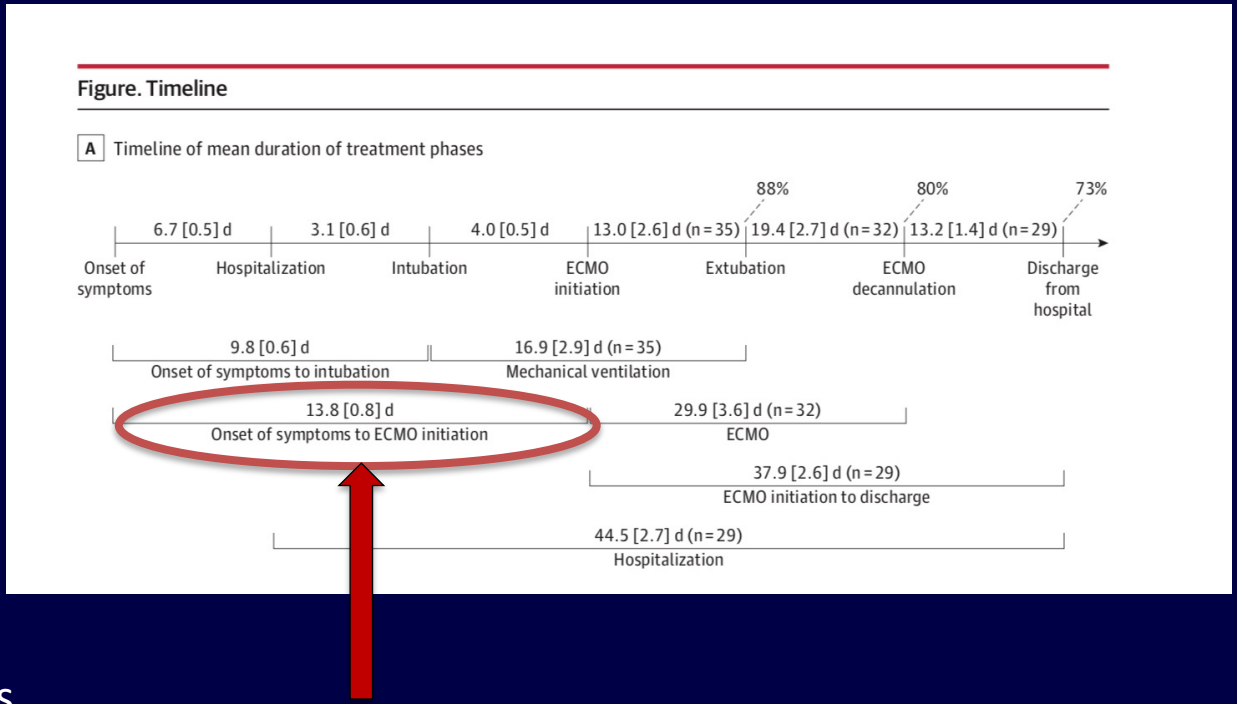
BMI=body-mass index. ECMO=extracorporeal membrane oxygenation. $PaCO_2$=partial pressure of arterial carbon dioxide. PaO_2:FiO_2=ratio of the partial pressure of arterial oxygen to the fraction of inspired oxygen. VA=venoarterial. VV=venovenous. VVA=venovenoaterial. *Dataset of 1031 patients; four observations were excluded due to having an initial cannulation mode that was not venovenous, venoarterial, or venovenoarterial.

Extracorporeal Membrane Oxygenation for Patients With COVID-19 in Severe Respiratory Failure

Asif K. Mustafa; et al

- N=40 patients
- EOLIA trial entry criteria
- 2- center Experience
- Onset of symptoms to ECMO: 13.8 days
- Single site access (RA-PA)
- Early Extubation
- Excellent outcomes

- Limitations:
  - Early reports
  - Retrospective study
  - No control group
  - Low number of patients



JAMA Surg. 2020;155(10):990-992.

Cytokine adsorption in patients with severe COVID-19 pneumonia requiring extracorporeal membrane oxygenation (CYCOV): a single center, open-label, randomized, controlled trial

- 34 patients
- 17 patients in each group
- Median IL-6 decreased from 357·0 pg/mL to 98·6 pg/mL in Cytokine adsorption group
- Median IL-6 decreased from 289·0 pg/mL to 112·0 pg/mL in the control group after 72 h
- Adjusted mean log IL-6 concentrations after 72 h were 0·30 higher in the cytokine adsorption group, p=0·54)
- Survival after 30 days was three (18%) in the cytokine adsorption group and 13 (76%) in the control group (p=0·0016)

Conclusions

Early initiation of cytokine adsorption in patients with severe COVID-19 and venovenous ECMO did not reduce serum IL-6 and had a negative effect on survival. Cytokine adsorption should not be used during the first days of ECMO support in COVID-19

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Alexander Supady, Lancet Respir Med. May 2021

Original research article

IJAO The International Journal of Artificial Organs

Clinical outcomes of severe COVID-19 patients receiving early VV-ECMO and the impact of pre-ECMO ventilator use

The International Journal of Artificial Organs
2021, Vol. 44(11) 861–867

DOI: 10.1177/0391398821047604
journals.sagepub.com/home/jao
SAGE

Chandra Kunavarapu[1], Samrat Yeramaneni[2], Jairo Melo[3], Rachel K Sterling[3], Lindsey C Huskey[2], Lindsay Sears[2], Charles Burch[3], Steve M Rodriguez[1], Phillip J Habib[1], Fernando Triana[4] and Jeffrey DellaVolpe[3]

Abstract

Acute respiratory distress syndrome (ARDS) in COVID-19 patients is associated with poor clinical outcomes and high mortality rates, despite the use of mechanical ventilation. Veno-Venous Extracorporeal membrane Oxygenation (VV-ECMO) in these patients is a viable salvage therapy. We describe clinical outcomes and survival rates in 52 COVID-19 patients with ARDS treated with early VV-ECMO at a large, high-volume center ECMO program. Outcomes included arterial blood gases, respiratory parameters, inflammatory markers, adverse events, and survival rates. Patients' mean

Table 3. Multivariable logistic regression association of pre-ECMO ventilator days and mortality.

Predictor variables	aOR	95% CI
Pre-ECMO ventilator days	**1.31**	**1.00–1.70**
Post-ECMO ventilator days	**1.03**	**1.00–1.07**
Age	1.03	0.97– 1.09
Female	0.82	0.21–3.26
BMI	1.11	0.98–1.25
Number of comorbid conditions	1.98	0.85–4.63

aOR: adjusted odds ratio.
Number of comorbid conditions was constructed as a continuous measure from presence of hypertension, diabetes, and asthma and summed for each patient to calculate total number of comorbidities, that ranged from zero to three.
Bold indicates that the variables are statistically significant at *p*-value less than 0.05.

- A single center experience, 52 patients, Mean age: 48 ± 12, mean BMI: 32 ±0.6

12 patients were placed on ECMO prior intubation with 75% survival to discharge vs 50% In the other group

- Pre-ECMO ventilator days was significantly associated with a 31% increased odds of mortality (aOR=1.31, 95% CI, 1.00–1.70) in a multivariable logistic regression model adjusted for age, gender, BMI,

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journal homepage: www.jcvaonline.com

Original Research

Persistent Right Ventricle Dilatation in SARS-CoV-2–Related Acute Respiratory Distress Syndrome on Extracorporeal Membrane Oxygenation Support

Chiara Lazzeri, MD[1], Manuela Bonizzoli, MD,, Stefano Batacchi, MD,, Giovanni Cianchi, MD,, ndrea Franci, MD,, Filippo Socci, MD,, Adriano Peris, MD

Intensive Care Unit and Regional ECMO Referral Centre, Azienda Ospedaliero-Universitaria Careggi, Florence, Italy

RV Dysfunction in Covid 19 related ARDS patients requiring VV ECMO

- 35 patients with COVID-related ARDS requiring ECMO
- Serial echocardiographic examination
- RvDys was defined as RV end-diastolic area/LV end-diastolic area>0.6 and tricuspidannular plane excursion<15 mm
- The incidence of RvDys was 15/35 (42%)
- RvDys patients underwent ECMO support after a longer period of mechanical ventilation ($p = 0.006$) and exhibited a higher mortality rate ($p = 0.024$) than those without RvDys.

Extracorporeal membrane oxygenation for COVID-19: evolving outcomes from the international Extracorporeal Life Support Organization Registry

Ryan P Barbaro, Graeme MacLaren*, Philip S Boonstra, Alain Combes, Cara Agerstrand, Gail Annich, Rodrigo Diaz, Eddy Fan, Katarzyna Hryniewicz, Roberto Lorusso, Matthew L Paden, Christine M Stead, Justyna Swol, Theodore J Iwashyna†, Arthur S Slutsky†, Daniel Brodie†, for the Extracorporeal Life Support Organization*

Lancet 2021; 398: 1230–38

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See Comment page 1197

*Joint first authors

†Contributed equally

Division of Pediatric Critical Care Medicine (R P Barbaro MD) **and Department of Biostatistics, School of Public Health** (P S Boonstra PhD), **University of Michigan, Ann Arbor, MI, USA; Cardiothoracic Intensive Care Unit, Department of Cardiac, Thoracic, and Vascular Surgery, National University Health System, Singapore** (G MacLaren MSc); **Sorbonne Université, INSERM, UMRS1166-ICAN, Institute of Cardiometabolism and Nutrition, Paris, France** (Prof A Combes MD); **Service de médecine intensive-réanimation, Institut de**

Summary

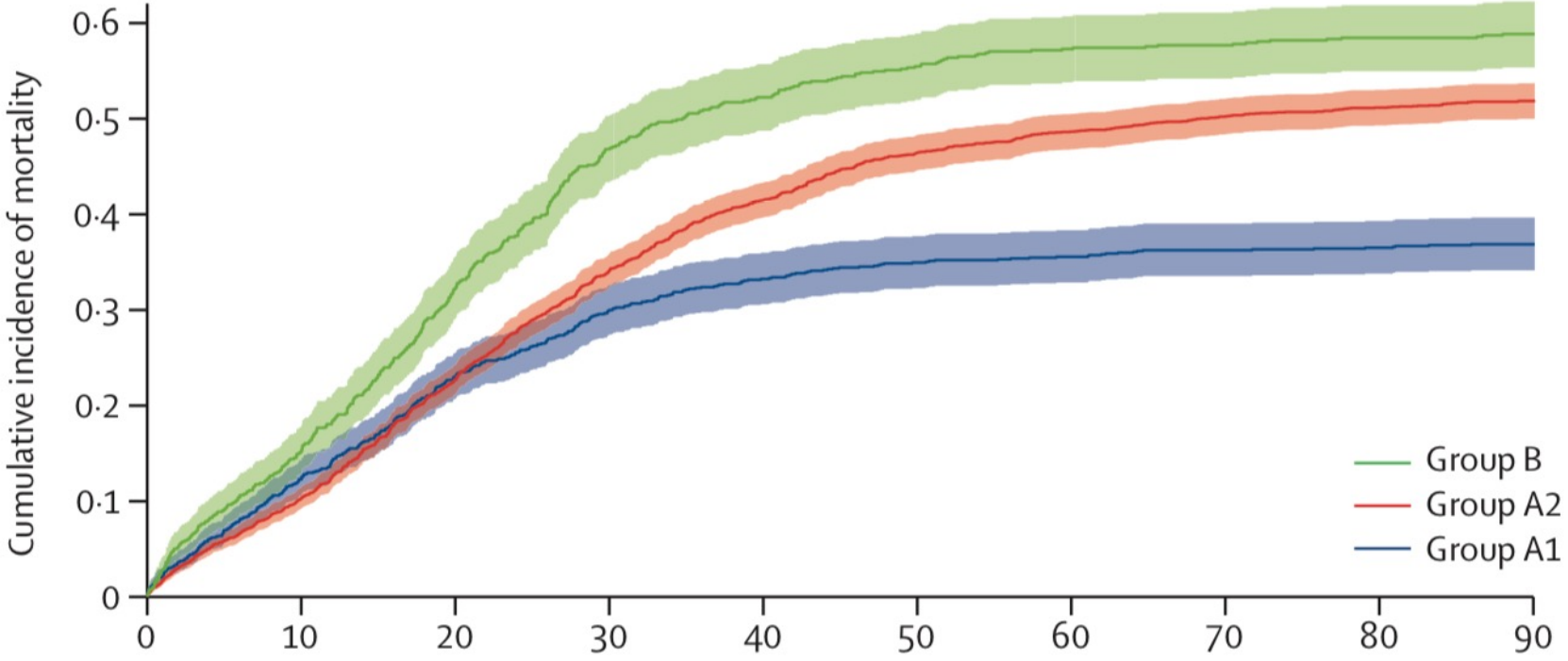
Background Over the course of the COVID-19 pandemic, the care of patients with COVID-19 has changed and the use of extracorporeal membrane oxygenation (ECMO) has increased. We aimed to examine patient selection, treatments, outcomes, and ECMO centre characteristics over the course of the pandemic to date.

Methods We retrospectively analysed the Extracorporeal Life Support Organization Registry and COVID-19 Addendum to compare three groups of ECMO-supported patients with COVID-19 (aged ≥16 years). At early-adopting centres—ie, those using ECMO support for COVID-19 throughout 2020—we compared patients who started ECMO on or before May 1, 2020 (group A1), and between May 2 and Dec 31, 2020 (group A2). Late-adopting centres were those that provided ECMO for COVID-19 only after May 1, 2020 (group B). The primary outcome was in-hospital mortality in a time-to-event analysis assessed 90 days after ECMO initiation. A Cox proportional hazards model was fit to compare the patient and centre-level adjusted relative risk of mortality among the groups.

Findings In 2020, 4812 patients with COVID-19 received ECMO across 349 centres within 41 countries. For early-adopting centres, the cumulative incidence of in-hospital mortality 90 days after ECMO initiation was 36·9% (95% CI 34·1–39·7) in patients who started ECMO on or before May 1 (group A1) versus 51·9% (50·0–53·8) after May 1 (group A2); at late-adopting centres (group B), it was 58·9% (55·4–62·3). Relative to patients in group A2, group A1 patients had a lower adjusted relative risk of in-hospital mortality 90 days after ECMO (hazard ratio 0·82 [0·70–0·96]), whereas group B patients had a higher adjusted relative risk (1·42 [1·17–1·73]).

Interpretation Mortality after ECMO for patients with COVID-19 worsened during 2020. These findings inform the role of ECMO in COVID-19 for patients, clinicians, and policy makers.

Funding None.



Number at risk

Group B	803	646	475	303	202	132	82	56	37	21
Group A2	2824	2471	1950	1404	1014	696	496	358	256	182
Group A1	1182	1012	765	513	348	234	156	110	84	60

Figure 1: **Cumulative incidence of mortality after ECMO initiation**

ECMO=extracorporeal membrane oxygenation. Group A1 patients started ECMO on or before May 1, 2020, at early-adopting centres. Group A2 patients started ECMO between May 2 and Dec 31, 2020, at early-adopting centres,. Group B patients received ECMO at late-adopting centres, which only provided ECMO for COVID-19 after May 1, 2020.

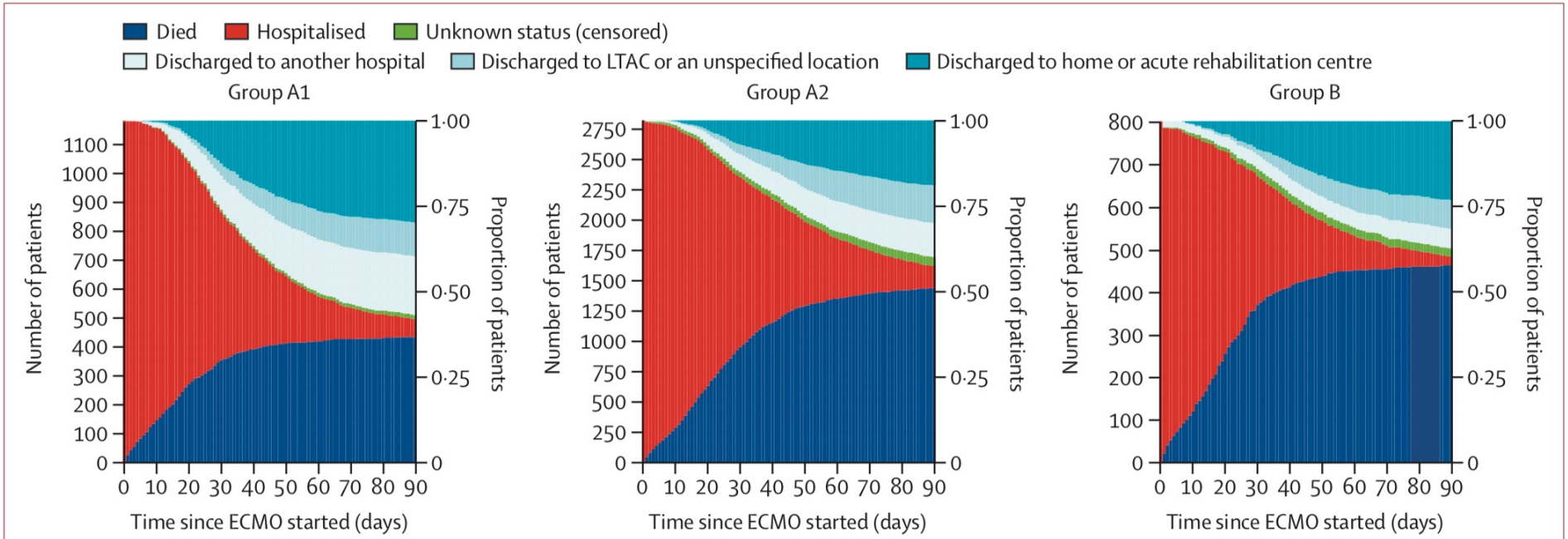


Figure 3: **Stacked bar plots of disposition for ECMO for COVID-19 among three cohorts**

Group A1 patients started ECMO on or before May 1, 2020, at early-adopting centres. Group A2 patients started ECMO after May 1 at early-adopting centres. Group B patients received ECMO at late-adopting centres, which only provided ECMO for COVID-19 after May 1, 2020. Unknown status (censored) refers to patients who, as of June 9, 2021, did not meet one of the following three criteria: died, discharged alive, or survived at least 90 days after ECMO started. Hospitalised patients are those who, as of June 9, 2021, are still in the hospital where ECMO support was started. ECMO=extracorporeal membrane oxygenation. LTAC=long-term acute care centre.

	Group A1	Group A2	Group B	p value: A1 *vs* A2	p value: A2 *vs* B
Participants	1182	2824	806	..	..
Pre-intubation non-invasive ventilation*	689 (58%)	2139 (76%)	564 (70%)	<0·001	0·16
Bilevel positive airway pressure	202 (17%)	939 (33%)	313 (39%)	<0·001	0·18
Continuous positive airway pressure	158 (13%)	385 (14%)	73 (9%)	1·00	0·19
High-flow nasal cannula	420 (36%)	1463 (52%)	341 (42%)	<0·001	0·036
More than one non-invasive support	83 (7%)	592 (21%)	151 (19%)	<0·001	0·47
Prone positioning†	700 (60%)	1684 (60%)	405 (51%)	0·96	0·022
Neuromuscular blockade‡	845 (73%)	2090 (74%)	506 (63%)	0·80	0·016
Any vasoactive support§	715 (61%)	1721 (61%)	455 (57%)	0·91	0·23
Pre-ECMO endotracheal intubation, days¶	4·0 (1·7–6·3)	3·1 (0·9–6·3)	2·7 (0·8–5·9)	<0·001	0·20
Pre-ECMO conventional ventilation‖	1086 (98%)	2498 (96%)	650 (97%)	0·018	0·47
$PaCO_2$, mm Hg**	60 (50–74)	61 (50–76)	60 (50–74)	0·48	0·46
PaO_2:FiO_2, mm Hg††	72 (60–94)	71 (58–92)	70 (56–93)	0·44	0·49
PEEP, cm of H_2O‡‡	14 (12–16)	14 (10–16)	14 (10–16)	1·00	1·00
PIP, cm of H_2O§§	33 (30–38)	34 (30–38)	34 (30–38)	0·87	1·00
PEEP, cm of H_2O at ECMO hour 24¶¶	10 (10–14)	10 (10–12)	10 (10–12)	1·00	1·00
PIP, cm of H_2O at ECMO hour 24‖‖	25 (21–28)	25 (21–28)	25 (22–29)	1·00	1·00
COVID-19 therapies					
Any	914 (77%)	2590 (92%)	644 (80%)	<0·001	<0·001
Glucocorticoids	511 (43%)	2196 (78%)	583 (72%)	<0·001	0·20
Remdesivir	103 (9%)	1598 (57%)	404 (50%)	<0·001	0·28
Chloroquine or hydroxychloroquine	627 (53%)	180 (6%)	63 (8%)	<0·001	0·45
Venovenous ECMO	1110 (94%)	2623 (93%)	762 (95%)	0·39	0·94
ECMO support type					
Respiratory support	1140 (96%)	2686 (95%)	777 (96%)	0·060	0·24
Cardiac support	29 (2%)	110 (4%)	27 (3%)	..	..
ECPR	13 (1%)	28 (1%)	2 (0·2%)	..	..

Hemocompatibility related events

	Group A1	Group A2	Group B
Last known patient status	1182	2824	806
Discharged			
To home or acute rehabilitation	376 (32%)	623 (22%)	190 (24%)
To long-term acute care or unspecified location	128 (11%)	329 (12%)	71 (9%)
To another hospital	212 (18%)	301 (11%)	47 (6%)
Remain in the hospital, discharged from ICU	2 (<1%)	5 (<1%)	1 (<1%)
Remain in the ICU	16 (1%)	78 (3%)	22 (3%)
In-hospital death	448 (38%)	1488 (53%)	475 (59%)
Select complications*	494 (45%)	1233 (52%)	363 (54%)
CNS infraction	7 (1%)	53 (2%)	8 (1%)
CNS haemorrhage	68 (6%)	196 (7%)	42 (5%)
Haemolysis	53 (5%)	219 (8%)	30 (4%)
Pump failure	10 (1%)	29 (1%)	12 (2%)
Oxygen failure	108 (9%)	370 (13%)	66 (8%)
Circuit change	161 (14%)	469 (17%)	71 (9%)

Data are n (%). Group A1 patients started ECMO on or before May 1, 2020, at early-adopting centres. Group A2 patients started ECMO between May 2 and Dec 31, 2020, at early-adopting centres. Group B patients started ECMO at late-adopting centres, which only provided ECMO for COVID-19 after May 1, 2020. Denominators for percentages are given in the footnotes when they differ from the last known patient status row. ECMO=extracorporeal membrane oxygenation. ICU=intensive care unit. *Group A1 n=1157, group A2 n=2767, group B n=782.

***Table 3:* ECMO outcomes among three cohorts with COVID-19**

Anticoagulation/Bleeding Management Challenges

- Lack of evidence based data
- Duration of support
- Lack of standardization:
  - ECMO Circuits
  - Reporting

ECMO/ECLS?

Impact of Center Volume and Experience on Outcomes

BJA

British Journal of Anaesthesia, 125 (3): 259–266 (2020)

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Cardiovascular

CARDIOVASCULAR

Outcomes of the NHS England National Extracorporeal Membrane Oxygenation Service for adults with respiratory failure: a multicentre observational cohort study

Alex Warren[1,2], Yi-Da Chiu[3,4], Sofía S. Villar[3], Jo-anne Fowles[2], Nicola Symes[5], Julian Barker[6], Luigi Camporota[7,8], Chris Harvey[9], Stephane Ledot[10], Ian Scott[11], Alain Vuylsteke[2,*] on behalf of the NHS England-commissioned National ECMO Service

[1]Division of Anaesthesia, Department of Medicine, School of Clinical Medicine, University of Cambridge, Cambridge, UK, [2]Critical Care Unit, Royal Papworth Hospital, Cambridge, UK, [3]MRC Biostatistics Unit, Cambridge Institute of Public Health, School of Clinical Medicine, University of Cambridge, Cambridge, UK, [4]Clinical Trials Unit, Royal Papworth Hospital, Cambridge, UK, [5]Highly Specialised Services, NHS England, London, UK, [6]Cardiothoracic Critical Care Unit, Wythenshawe Hospital, Manchester, UK, [7]Department of Critical Care, Guy's & St Thomas' Hospitals, London, UK, [8]Division of Asthma, Allergy and Lung Biology, King's College London, London, UK, [9]University Hospitals of Leicester, Leicester, UK, [10]Adult Intensive Care Unit, Royal Brompton & Harefield Hospitals, London, UK and [11]Intensive Care Unit, Aberdeen Royal Infirmary, Aberdeen, UK

*Corresponding author. E-mail: a.vuylsteke@nhs.net

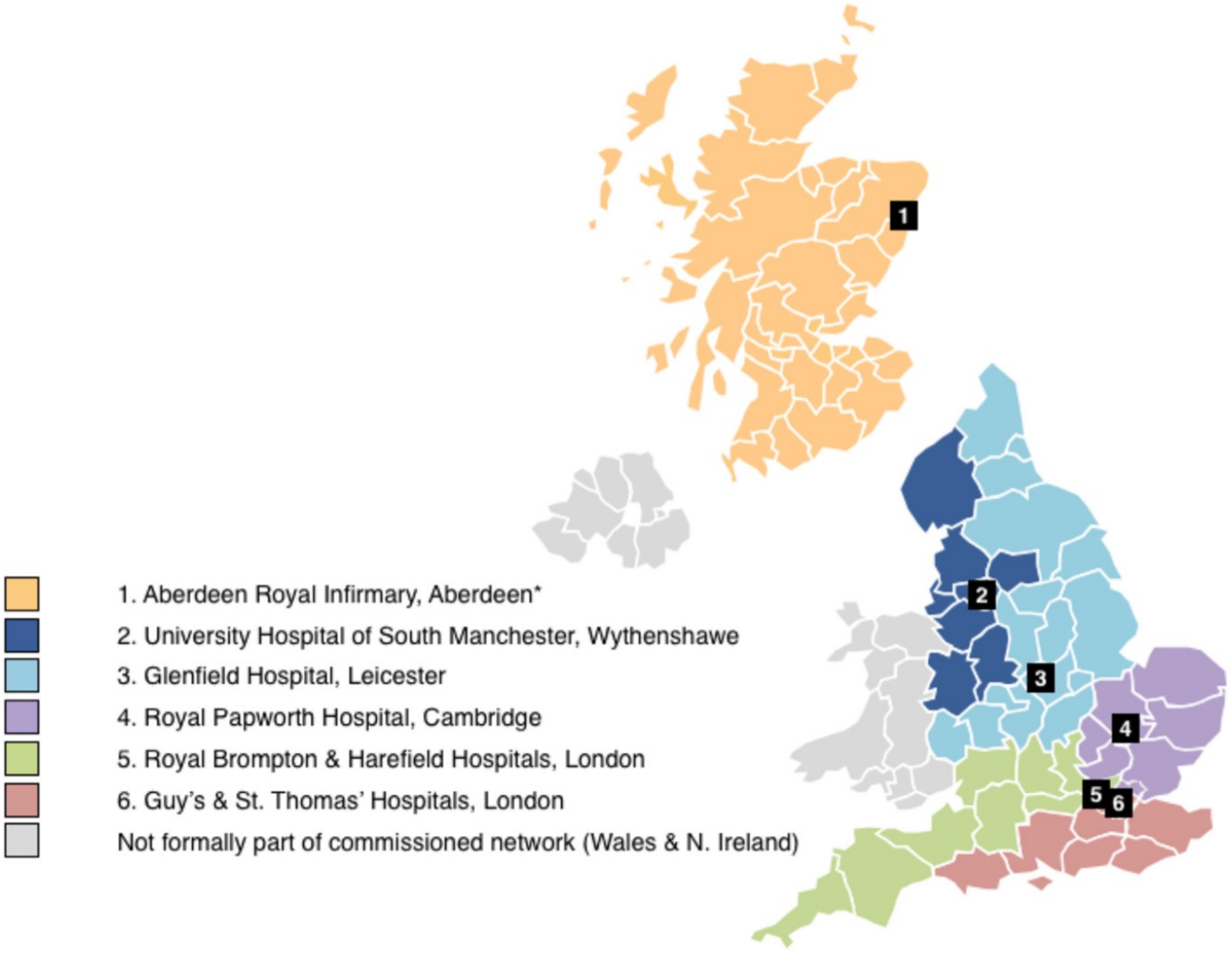
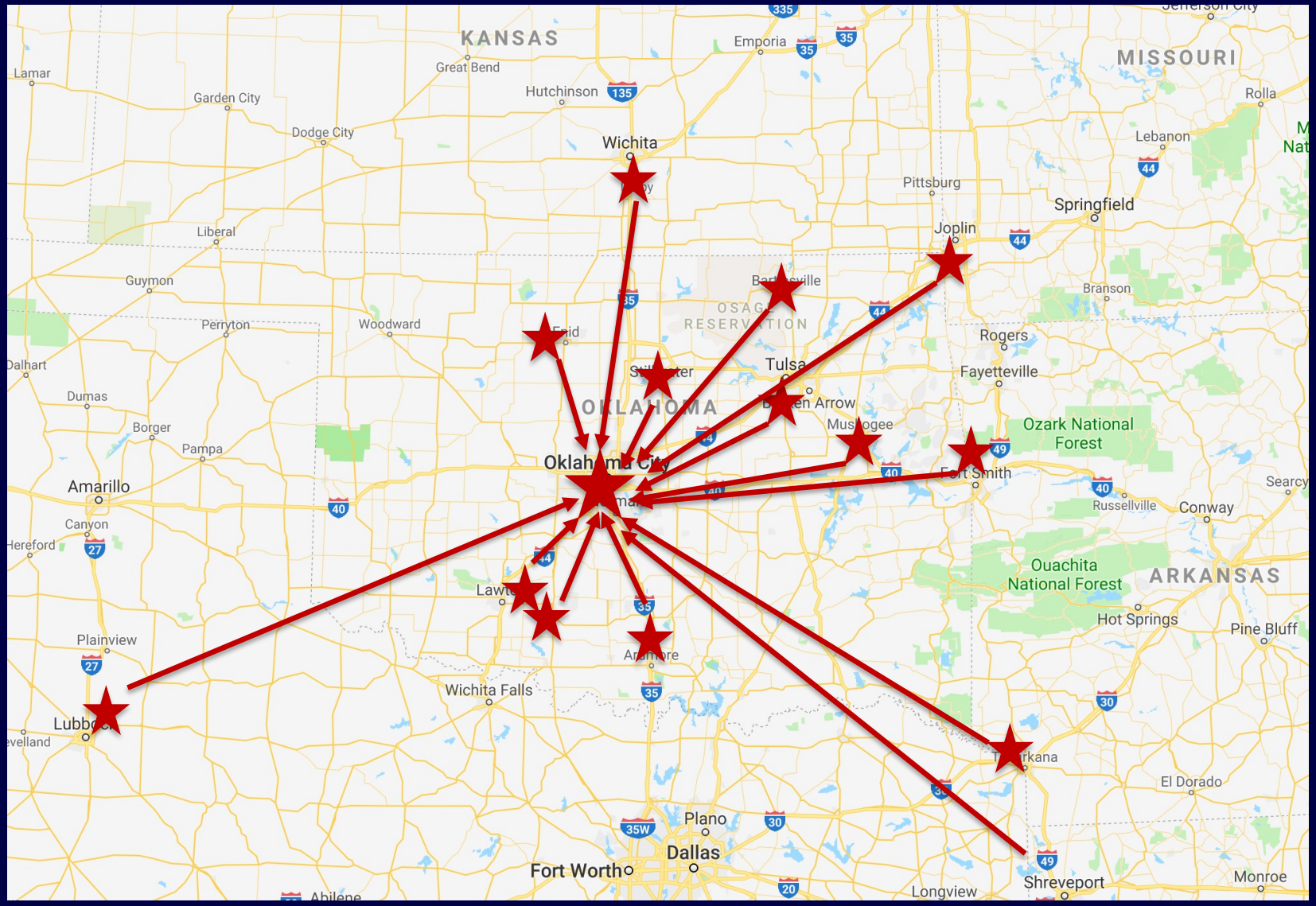


Fig 1. Geographic distribution of the NHS ECMO network across England and Scotland. ECMO, extracorporeal membrane oxygenation.

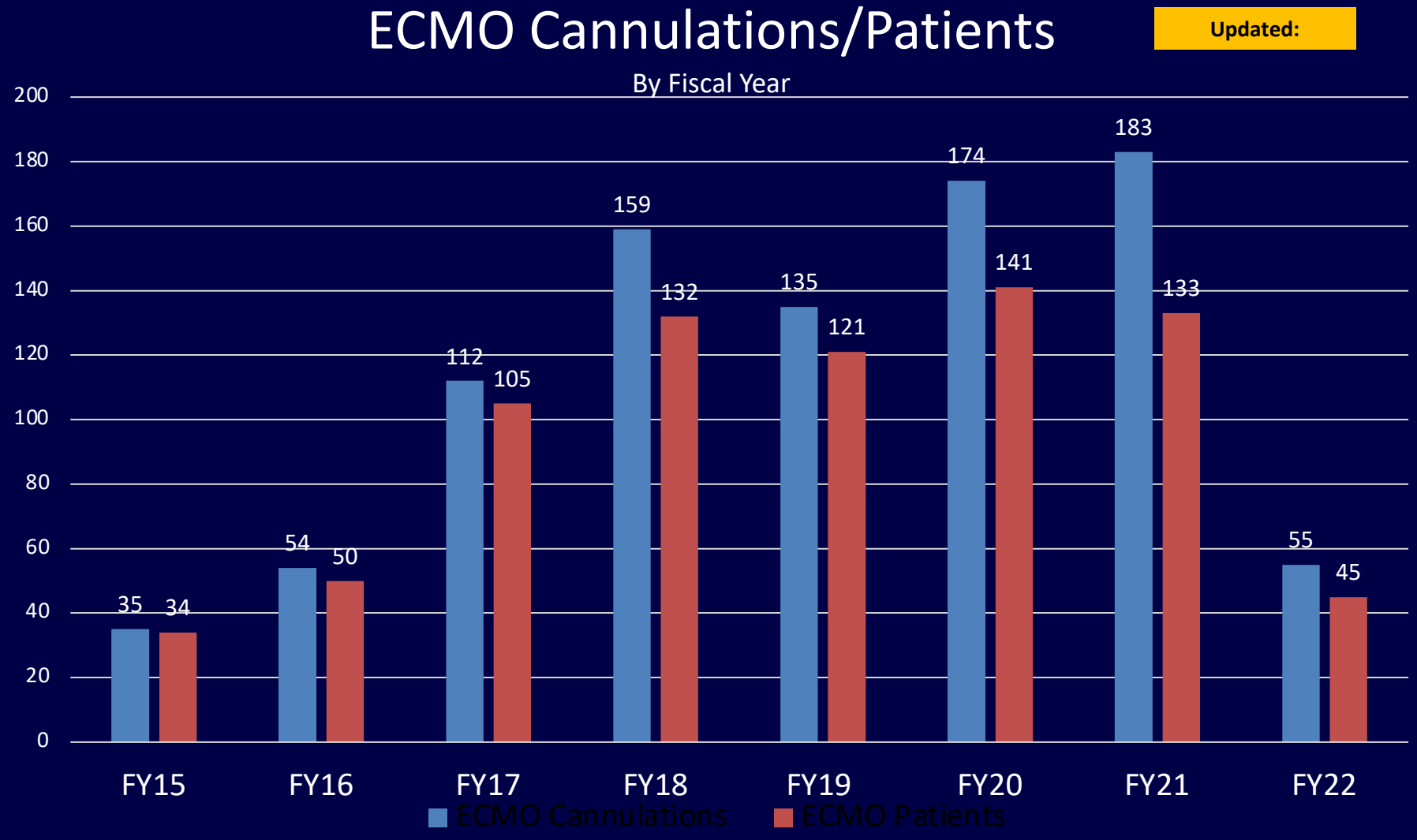
Impact of Center Volume and Experience on Outcomes

- 1321 ARDS Patients
- Six centers
- December 1, 2011 to December 31, 2017
- Median age:44, 55% males
- Median PaO2/FiO2: 70
- Median MV time: 24h
- Viral pneumonia was the most common primary diagnosis 22% followed by bacterial pneumonia (20%)
- 74% survival to ICU discharge

INTEGRIS Regional Hub and Spoke Model



INTEGRIS Regional ECMO Program
> 700 patients



INTEGRIS Regional ECMO Program Outcomes

Outcomes- Survived to Discharge

ECMO Type:	N	N Survived to Discharge	% Survived to Discharge
VA - Acute	137	68	50%
VA - Acute on chronic	58	32	55%
VA - CPR	89	28	31%
VA - post cardiotomy	99	48	48%
VA - post heart tx	11	7	64%
VA - post lung tx	5	1	20%
VA - post LVAD	7	2	25%
VA - pre LTX	4	3	75%
VA - Respiratory	35	12	34%
VV - ARDS	250	154	62%
VV - post LTX	5	5	100%
VV-pre lung tx	23	10	43%
VAV	4	0	0%
VVA	1	0	0%
VPA (Protek)	12*	6	50%
VV-COVID	81	48	59%
VV-(excluding COVID)	194	122	63%
VA (excluding CPR)	357	174	49%
VV	275	170	62%

Oklahoma Shock and ECMO Network: COVID 19 ARDS Experience (n=81 patients)

- Right Fem- Right IJ approach
- 23-25 F cannula
- ECMO Flow> 4l/min
- PTT Target (40-60)
- Lung protective vent strategy
- Prone on ECMO
- Consider onset of symptoms to cannulation time
- Fluid restriction
- Extubate if feasible
- Accept suboptimal O2 saturation > 80% in select cases
- Early tracheostomy (3-5 days)
- Consider ProtekDue in case of severe RV failure

IBMC-OKLAHOMA APPROACH

Inclusion Criteria for Covid-19 related ARDS
A Moving target

ECMO Conventional Criteria as of April 2020 (Level I)

Inclusion Criteria

1. Age ≤70 years
2. Severe reversible ARDS (PaO2:FiO2 <100) despite optimum management, including:
   a. lung protective ventilator settings
   b. neuromuscular blockade
   c. inhaled vasodilators
   d. proning trial
3. Lactic acid <8 for VV ECMO
4. Lactic acid <15 for VA ECMO
5. Legal decision-maker available
6. Exit strategies in place and discussed with patient and/or legal decision-maker

…CMO Contingency Criteria as of October 2020 (Level II)

Enhanced Inclusion Criteria

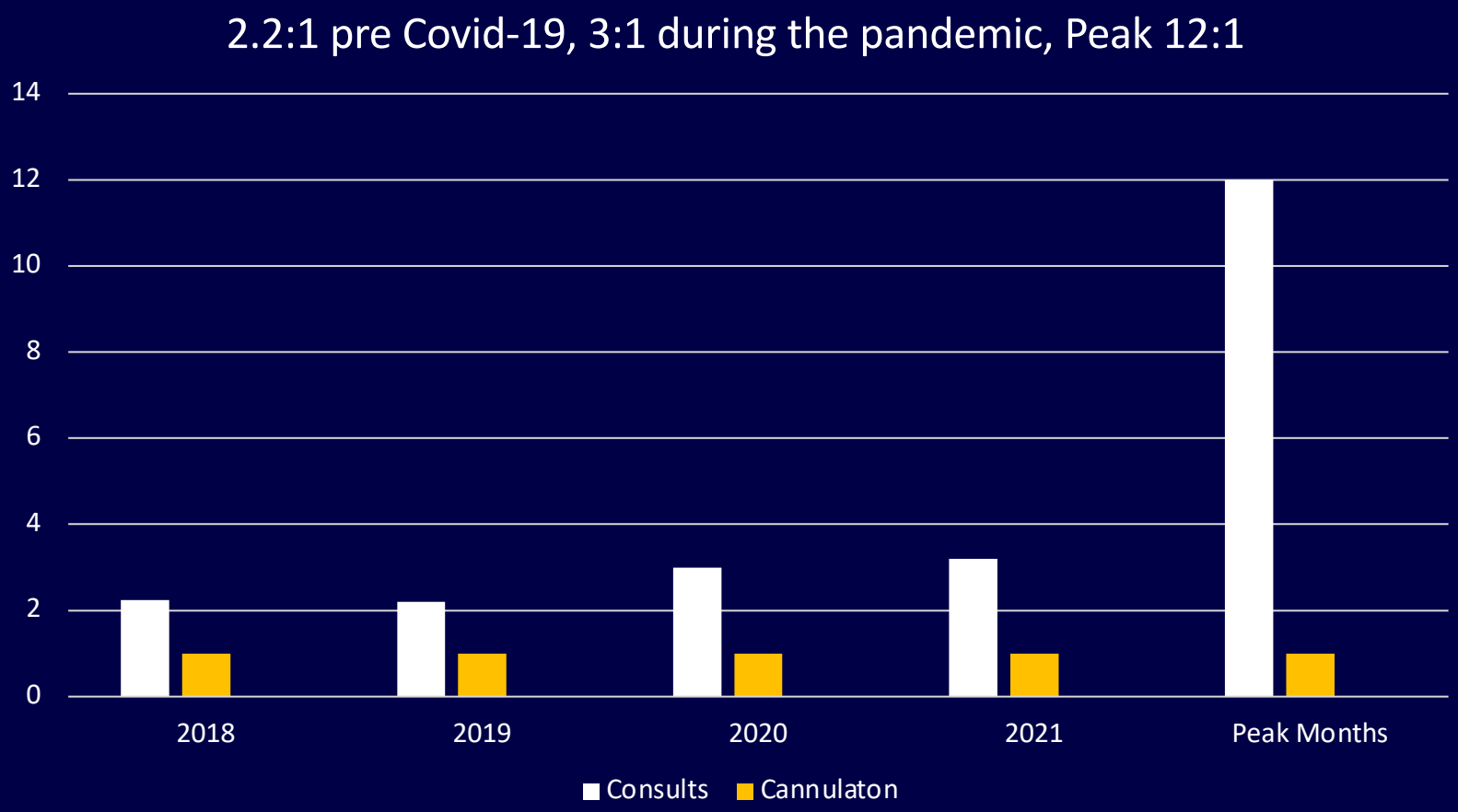
1. Age <60 years
2. Severe ARDS or Murray score >3
3. Failure of optimum management, including lung protective ventilator settings neuromuscular blockade, inhaled vasodilators, and proning trial
4. Mechanical ventilation ≤7 days
5. Lactic acid <8 for VV ECMO
6. Legal decision-maker available
7. Exit strategies in place and discussed with patient and/or legal decision-maker

ECMO Crisis Criteria as of January 2021 (Level III)

Stringent Inclusion Criteria

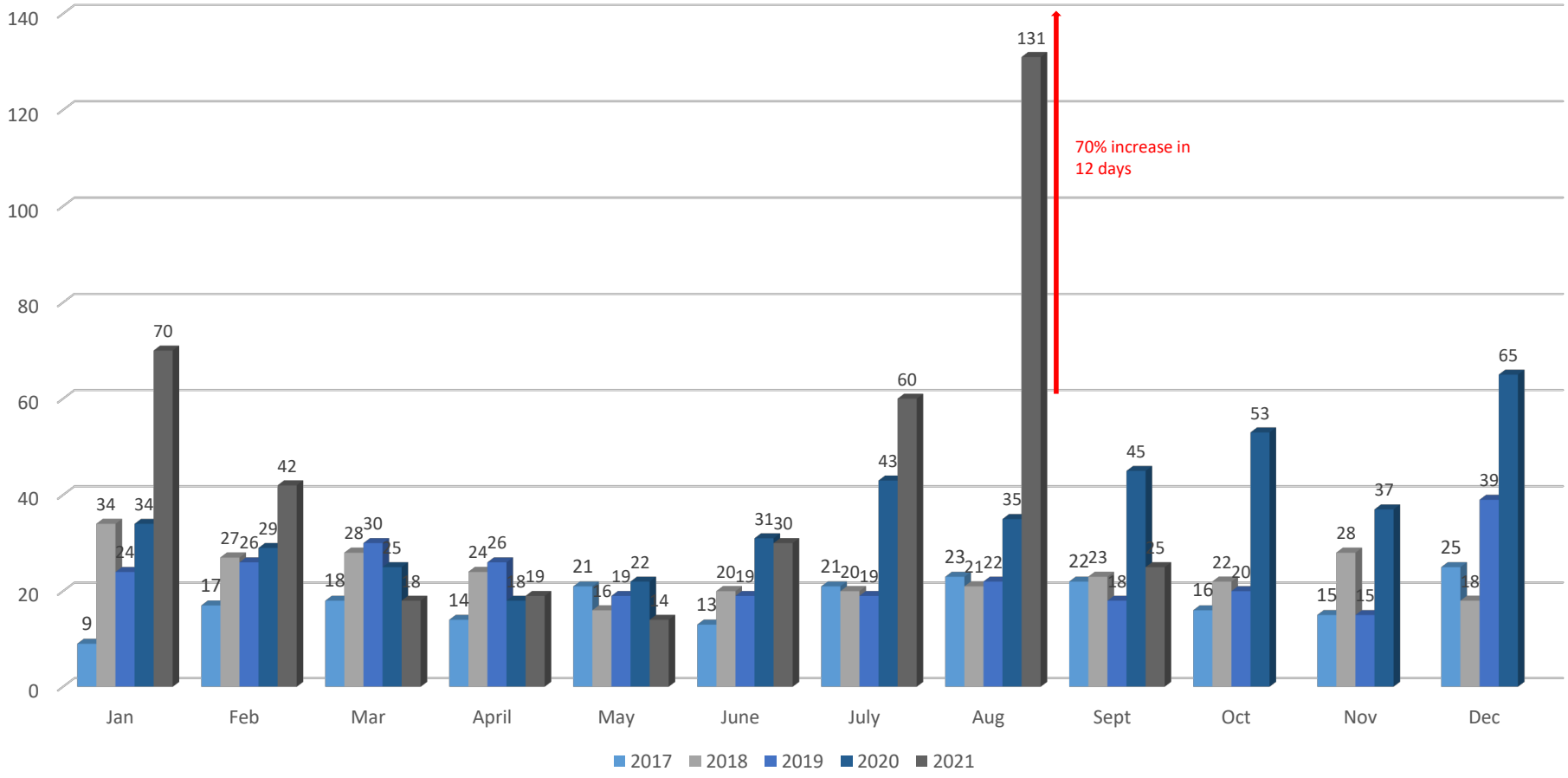
1. Age <50 years
2. Severe ARDS or Murray score >3
3. Failure of optimum management, including lung protective ventilator settings, neuromuscular blockade, inhaled vasodilators, and proning trial
4. Mechanical ventilation ≤5 days
5. Lactic acid < 5
6. Legal decision-maker available
7. Exit strategies in place and discussed with patient and/or legal decision-maker

ECMO Network Consults / Acceptance Ratio During the Surge in a High Volume ECMO Center



Hotline Calls by Month

As of 9/7/2021



ECMO in COVID-19 Patients: IBMC Experience (as of September 2021, n=81)

Baseline Characteristics (Pre-ECMO)

Age (yrs)	45 ± 12 (20-73)
Sex (f/%)	32 (40%)
Race	
Caucasian	49 (60%)
Hispanic	24 (30%)
African American	5 (6%)
Others	3 (4%)

ECMO in COVID-19 Patients: IBMC Experience (as of September 2021, n=81)

Outcomes

HLOS (d)	42 ± 33
Duration of support (d)	27 ± 20 (2-120)
Hospital mortality	33 (41%)
Weaned	52 (64%)
Discharged	***48 (59%)***
Off anticoagulation	***38 (47%)***
Tracheostomy	21 (26%)
Extubation while on ECMO	15 (19%)

ECMO in COVID-19 Patients: IBMC Experience (as of September 2021, n=81)

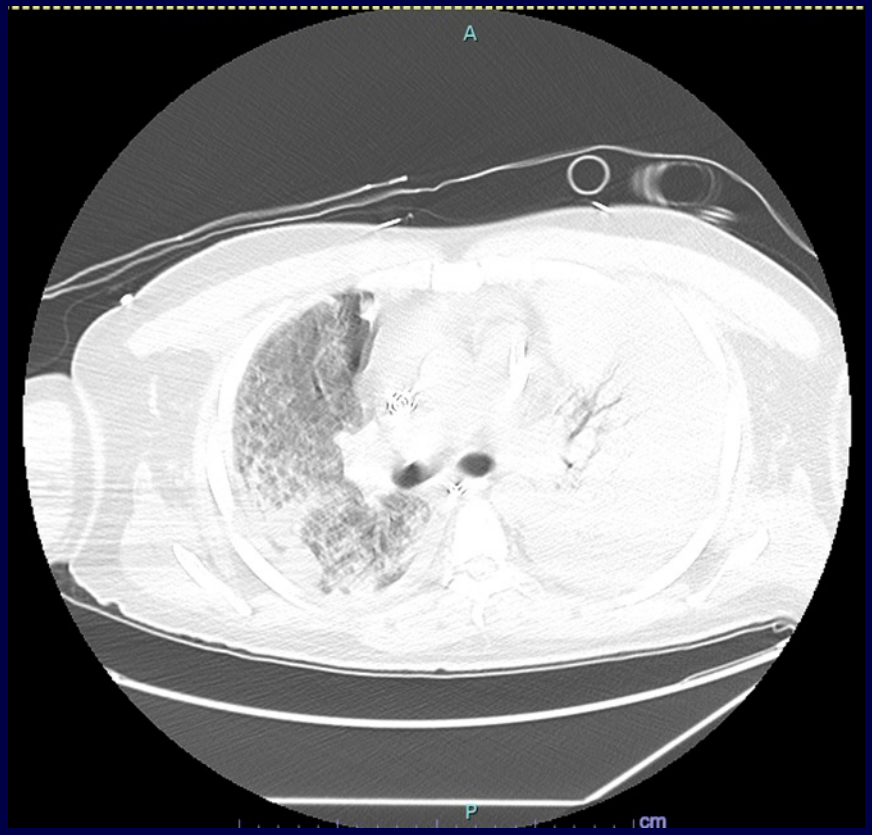
Main Complications

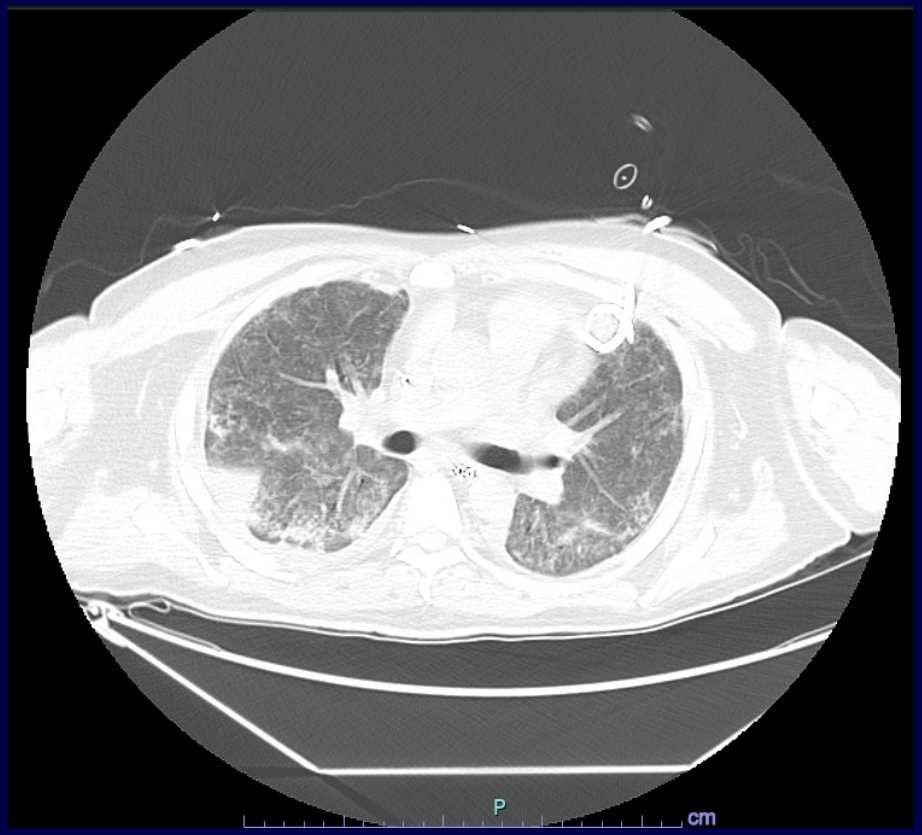
Circuit Change	***44 circuits/34 patients****
VAP	18 (22%)
Oro-pharyngeal bleed	13 (16%)
Pneumothorax	12 (15%)
GI Bleeding	9 (11%)
Bacteremia	8 (10%)
Intracranial hemorrhage	2 (2%)
RP Bleeding	2 (2%)

*0.022 EP ECMO day in non COVD Patients vs. 0.026 in Covid 19 patients

ECMO in COVID-19 Patients: IBMC Experience (Predictors of Discharge)

	Successfully discharged	Died on Support	P=
Age (years)	41±12	51±11	**0.003**
BMI	34±9	42±12	**0.012**
Pre-ECMO HLOS	5±4	11±17	0.087
Gender (f/m)	52%/48%	48%/52%	0.7
PH	7.37	7.32	0.06
SOFA Score	9.4±3	9.1±2	0.6
IBMC cannulation vs others	55%/42%	45%/58%	0.57
Duration of support (days)	20±16	33±23	**0.018**





CT done less than 2 weeks apart, relatively late into the disease course (>30 days)

Summary

- EOLIA Trial entry criteria are widely accepted and utilized for Covid-19 patients requiring VV ECMO; however, many centers were not able to follow them because of the pandemic related capacity and resources issues
- Survival rate of VV-ECMO Patients with severe ARDS secondary to Covid-19 is similar to non- Covid Patients
- Duration of ECMO support is longer in Covid-19 ARDS patients compared to non Covid ARDS patients (longer Lung recovery time)

Summary

- More data are required to address the following challenges
  - Anticoagulation
  - Cannulation modalities
  - appropriate timing and patient selection
  - Transplant candidacy
  - Futility

- During the surge it is recommended to,
  - Adapt Inclusion criteria to hospitalization/capacity ratio
  - Collaborate with other Programs in your region (inclusion criteria, Futility criteria
  - Consider SRA policy