



Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.

Contents lists available at [ScienceDirect](https://www.sciencedirect.com)

Journal of Cardiothoracic and Vascular Anesthesia

journal homepage: www.jcvaonline.com

Original Article

Variation in Hospitalization Costs, Charges, and Lengths of Hospital Stay for Coronavirus Disease 2019 Patients Treated With Venovenous Extracorporeal Membrane Oxygenation in the United States: A Cohort Study

Michael Mazzeffi, MD, MPH, MSc^{*,1}, Jonathan Curley, MD^{*},
Paul Gallo, MD^{*}, D Keegan Stombaugh, MD^{*}, Joshua Roach, MD^{*},
Nadia Lunardi, MD^{*}, Kenan Yount, MD[†], Robert Thiele, MD^{*},
Laurent Glance, MD[‡], Bhiken Naik, MD^{*}

^{*}Department of Anesthesiology, University of Virginia Health, Charlottesville, Virginia

[†]Department of Surgery, Division of Cardiothoracic Surgery, University of Virginia Health, Charlottesville, Virginia

[‡]Department of Anesthesiology, University of Rochester, Rochester, New York



Objectives: The aim was to characterize hospitalization costs, charges, and lengths of hospital stay for COVID-19 patients treated with venovenous (VV) extracorporeal membrane oxygenation (ECMO) in the United States during 2020. Secondly, differences in hospitalization costs, charges, and lengths of hospital stay were explored based on hospital-level factors.

Design: Retrospective cohort study.

Setting: Multiple hospitals in the United States.

Participants: Adult patients with COVID-19 who were on VV ECMO in 2020 and had data in the national inpatient sample.

Interventions: None.

Measurements and Main Results: Demographics and baseline comorbidities were recorded for patients. Primary study outcomes were hospitalization costs, charges, and lengths of hospital stay. Study outcomes were compared after stratification by hospital region, bed size, and for-profit status. The median hospitalization cost for the 3,315-patient weighted cohort was \$200,300 (\$99,623, \$338,062). Median hospitalization charges were \$870,513 (\$438,228, \$1,553,157), and the median length of hospital stay was 30 days (17, 46). Survival to discharge was 54.4% for all patients in the cohort. Median hospitalization cost differed by region ($p = 0.01$), bed size ($p < 0.001$), and for-profit status ($p = 0.02$). Median hospitalization charges also differed by region ($p = 0.04$), bed size ($p = 0.002$), and for-profit status ($p < 0.001$). Length of hospital stay differed by region ($p = 0.03$) and bed size ($p < 0.001$), but not for-profit status ($p = 0.40$). Hospitalization costs were the lowest, and charges were highest in private-for-profit hospitals. Large hospitals also had higher costs, charges, and hospital stay lengths than small hospitals.

Conclusions: In this retrospective cohort study, hospitalization costs and charges for patients with COVID-19 on VV ECMO were found to be substantial but similar to what has been reported previously for patients without COVID-19 on VV ECMO. Significant variation was observed in costs, charges, and lengths of hospital stay based on hospital-level factors.

© 2023 Elsevier Inc. All rights reserved.

Key Words: ECMO; cost; charges; economics; COVID-19

¹Address correspondence to Michael Mazzeffi, MD, MPH, MSc, University of Virginia Health, Department of Anesthesiology, PO Box 800710, Charlottesville, VA 22908.

E-mail address: mmazzeff@virginia.edu (M. Mazzeffi).

ACCORDING TO the Extracorporeal Life Support Organization, as of March 1, 2023, venovenous (VV) extracorporeal membrane oxygenation (ECMO) has been used to support >16,500 patients worldwide with COVID-19.¹ Of these

patients, 53% survived to hospital discharge.¹ Patients with COVID-19 on VV ECMO created unique challenges for healthcare providers and hospitals in the United States, as some patients had long ECMO runs that exceeded those of patients with other viral causes of acute respiratory distress syndrome (ARDS).^{2,3} Patients with COVID-19 on VV ECMO also had increased complications, including bleeding, thrombosis, and stroke.³⁻⁵

Extracorporeal membrane oxygenation is resource-intensive therapy, and costs have been historically substantial for adult patients. In a recent systematic review, the costs of ECMO in the United States were between \$50,000 and \$350,000 per patient, depending on the indication.⁶ In the same review, 4 studies of patients on VV ECMO found the mean hospitalization cost to be between \$50,000 and \$200,000.⁶ In a recently published study of ECMO charges in the United States, which used data from the national inpatient sample (NIS) between 2008 and 2016, mean ECMO charges for VV ECMO were close to \$830,000, and mean length of hospital stay was 29 days.⁷

The primary study objective was to characterize hospitalization costs, charges, and lengths of hospital stay for patients on VV ECMO with COVID-19 in the United States during the first year of the COVID-19 pandemic. Given the high complexity of care reported for patients with COVID-19, the authors hypothesized that hospitalization costs, charges, and lengths of hospital stay for patients on VV ECMO with COVID-19 would be higher than what has been reported previously for patients on VV ECMO without COVID-19. Secondly, they explored differences in hospitalization costs, charges, and lengths of hospital stay based on hospital characteristics. The hypothesis was that the highest hospitalization costs, charges, and longest lengths of stay would be observed in large, not-for-profit hospitals.

Methods

Patients

The study was confirmed to be nonhuman subjects research by the University of Virginia institutional review board, as the NIS is a fully deidentified publicly available data set. The NIS is a stratified cohort that contains discharge data for approximately 20% of all hospitalizations in the United States, or approximately 7 million patients (<https://hcup-us.ahrq.gov/nisoverview.jsp>). The NIS is publicly available for purchase and can be accessed after appropriate training is completed. Adult patients (≥ 18 years of age) who had COVID-19 and received VV ECMO during their hospitalization were identified in the 2020 NIS. Patients who were missing data on hospitalization charges were excluded. Specifically, International Classification of Disease (10th Revision) diagnosis and Procedure Coding System codes were used to identify patients with COVID-19 (U07.1) who were treated with peripheral VV ECMO (5A1522H). For all patients, details were collected regarding demographics, common comorbidities (obesity, hypertension, diabetes), Charlson comorbidity index score,

details on the hospital and region where the patient was treated, insurance status, and whether the patient received lung transplantation during their hospitalization. Definitions for variables were based on Healthcare Cost and Utilization Project (HCUP) definitions (<https://www.hcup-us.ahrq.gov/db/nation/nis/nisdde.jsp>). A list of data contributors can be found at the following link: www.hcup-us.ahrq.gov/hcupdatapartners.jsp.

Outcomes

The study's primary outcomes were estimated hospitalization costs, charges in United States dollars, and lengths of hospital stay. Estimated hospitalization costs were calculated using charges and cost-to-charge ratios provided by HCUP. Secondary outcomes were in-hospital mortality, ischemic and hemorrhagic stroke, and acute renal failure. Ischemic stroke, hemorrhagic stroke, and acute renal failure were identified in the NIS using the International Classification of Disease (10th Revision) diagnosis codes (I63, I61, and N17 parent codes, respectively).

Statistical Analysis

Statistical analysis was performed using SAS 9.4 (SAS Corporation, Cary, NC). Patient characteristics were summarized as median and IQR [Q1, Q3] or number and percentage of patients. Variables were weighted based on HCUP recommendations, using discharge weights so that final study estimates were representative of all patients on VV ECMO with COVID-19 in the United States during 2020. This represented all patients among approximately 35 million hospitalizations. Differences in baseline patient characteristics and study outcomes were tested between groups using the Kruskal-Wallis Test (continuous variables) or chi-square test (categorical variables) as appropriate. Box and whisker plots were created for hospital costs, charges, and lengths of hospital stay. For all statistical comparisons, p values < 0.05 were considered statistically significant. In concert with NIS requirements, cell counts with a value ≤ 10 were not reported.

Results

The weighted cohort contained 3,315 patients with COVID-19 who were treated with peripheral VV ECMO in 2020. During the same period, 3,205 patients on VV ECMO for non-COVID-19 reasons were identified. Characteristics of patients with COVID-19 who were treated with VV ECMO are listed in [Table 1](#). The median age was 51 years; 68.8% of the patients were men; 17.6% (585) were Black; and 33.8% (1120) were Hispanic, with most patients being non-White. The oldest patient in the cohort was 79 years old. Most patients had either private health insurance (52.6% [1,745]) or Medicaid insurance (25.0% [830]), and most (94.4% [3,130]) were treated in urban teaching hospitals.

[Table 2](#) lists outcomes for patients with COVID-19 who were treated with VV ECMO. The median hospitalization cost was \$200,300 (IQR: \$99,623, \$338,062). The median

Table 1
Patient Characteristics

Variable	Full Weighted Cohort N = 3,315
Age (y)	51 (Q1 42, Q3 58)
Sex (% men)	2,280 (68.8)
Race	
White	1,110 (33.5)
Black	585 (17.6)
Hispanic	1,120 (33.8)
Asian or Pacific Islander	100 (3.0)
Native American	65 (2.0)
Other	150 (4.5)
No data	185 (5.6)
Primary payer	
Medicare	335 (10.1)
Medicaid	830 (25.0)
Private	1,745 (52.6)
Self-pay	175 (5.3)
Other	230 (7.0)
Admit month	
January-March	220 (6.6)
April-June	1,245 (37.6)
July-September	1,080 (32.6)
October-December	770 (23.2)
Teaching hospital	
Urban nonteaching or rural	185 (5.6)
Urban teaching	3,130 (94.4)
Hospital type	
Government, non-federal	360 (10.9)
Private, non-profit	2,605 (78.6)
Private, for-profit	350 (10.5)
Hospital region	
Northeast	600 (18.1)
North Central/Midwest	710 (21.4)
South	1,510 (45.6)
West	495 (14.9)
Bed-size category	
Small	200 (6.0)
Medium	475 (14.3)
Large	2,640 (79.6)
Obesity	1,655 (49.9)
Chronic lung disease	505 (15.2)
Hypertension (complicated)	535 (16.1)
Hypertension (uncomplicated)	1,075 (32.4)
Diabetes mellitus (complicated)	850 (25.6)
Diabetes mellitus (uncomplicated)	280 (8.4)
Charlson comorbidity index	2 (Q1 1, Q3 3)

NOTE. Weighted cohort represents estimated numbers for all hospitalized adult venovenous extracorporeal membrane oxygenation patients with COVID-19 in the United States during 2020. Values are presented as number (%) or median (Q1, Q3).

hospitalization charge was \$870,513 (IQR: \$438,228, \$1,553,157), and the median length of hospital stay was 30 days (IQR: 17, 46). Patients who were on VV ECMO for non-COVID-19-related respiratory failure during the same period had a significantly lower median hospitalization cost of \$167,428 (IQR: \$87,143, \$295,517) ($p < 0.001$), a significantly lower median hospitalization charge of \$674,086 (IQR: \$349,511, \$1,288,928) ($p < 0.001$), and a shorter median hospital stay of 22 days (IQR: 11, 38) ($p < 0.001$). The maximum hospitalization cost for individual patients with COVID-19

Table 2
Outcomes

Variable	Weighted Cohort Median, (Q1, Q3) or n (%) N = 3,315
Estimated hospitalization cost (\$) *	200,300 (Q1 99,623, Q3 338,062)
Total hospitalization charges (\$) †	870,513 (Q1 438,228, Q3 1,553,157)
Length of hospital stay ‡	30 (Q1 17, Q3 46)
Survival to hospital discharge	1,805 (54.5)
Hemorrhagic stroke	190 (5.7)
Ischemic stroke	90 (2.7)
Acute renal failure	2,145 (64.7)

NOTE. Values are presented as number (%) or median (Q1, Q3).

* Range was \$45 to \$1,370,616.

† Range was \$182 to \$8,592,785.

‡ Range was 1 to 209.

treated with VV ECMO during 2020 was \$1,370,616. The maximum hospitalization charge was \$8,592,785, and the maximum length of hospital stay was 209 days. The survival to discharge for all patients with COVID-19 on VV ECMO was 54.4%, compared to 67.9% for patients without COVID-19 on VV ECMO ($p < 0.001$). Of the patients with COVID-19 on VV ECMO, 0.3% received bilateral lung transplantation during the same hospitalization, and their median hospitalization cost was \$697,653 (IQR: \$390,982, \$1,004,324), median hospitalization charge was \$3,142,580 (IQR: \$1,761,178, \$4,523,982), and the median length of hospital stay was 108 days (IQR: 56, 160).

Supplemental Tables S1, S2, and S3 report patient characteristics after stratification by hospital region, hospital bed size, and hospitals' for-profit status. There were significant differences in demographics and baseline medical comorbidities by region, hospital bed size, and hospitals' for-profit status. Figure 1 shows hospitalization cost after stratifying by region (A), bed size (B), and for-profit status (C). Median hospitalization cost differed significantly by region ($p = 0.01$), bed size ($p < 0.001$), and for-profit status ($p = 0.02$). Median hospitalization cost by region was Northeast (\$191,775), North Central/Midwest (\$198,344), South (\$197,165), and West (\$250,641). Median hospitalization cost by hospital bed size was small (\$109,976), medium (\$173,297), and large (\$213,488). Median hospitalization cost by for-profit status was nonfederal government (\$233,423), private not-for-profit (\$202,084), and private for-profit (\$153,049).

Figure 2 shows hospitalization charges after stratifying by hospital region (A), bed size (B), and for-profit status (C). Median hospitalization charges differed by region ($p = 0.04$), bed size ($p = 0.002$), and for-profit status ($p < 0.001$). The median hospitalization charge by region was Northeast (\$859,733), North Central/Midwest (\$758,298), South (\$875,811), and West (\$1,074,407). The median hospitalization charge by bed size was small (\$582,594), medium (\$690,244), and large (\$895,466). Median hospitalization charge by for-profit status was nonfederal government (\$736,203), private not-for-profit (\$844,438), and private for-profit (\$1,524,081).

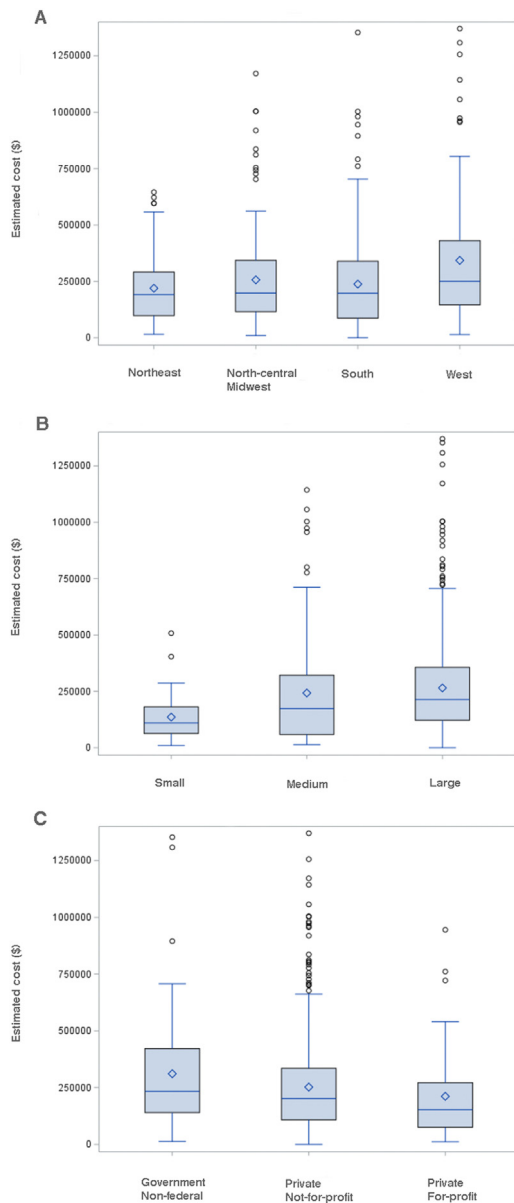


Fig 1. Box and whisker plots showing estimated hospitalization costs by region (A), hospital bed size (B), and hospital for-profit status (C).

Figure 3 shows the lengths of hospital stay after stratifying by region (A), bed size (B), and for-profit status (C). Lengths of hospital stay differed significantly by region ($p = 0.03$) and bed size ($p < 0.001$), but not for-profit status ($p = 0.40$). The median length of hospital stay was Northeast (28 days), North Central/Midwest (30 days), South (31 days), and West (29 days). The median length of hospital stay by bed size was small (18 days), medium (25 days), and large (31 days). The median length of hospital stay by for-profit status was nonfederal government (31 days), private not-for-profit (30 days), and private for-profit (27 days).

Survival to discharge differed by hospital region ($p < 0.001$) and for-profit status ($p < 0.001$), but not by bed size ($p = 0.06$). Survival to discharge was Northeast (47.5%), North Central/Midwest (59.2%), South (54.6%), and West (55.6%). Survival to discharge by hospital bed size was small (62.5%), medium

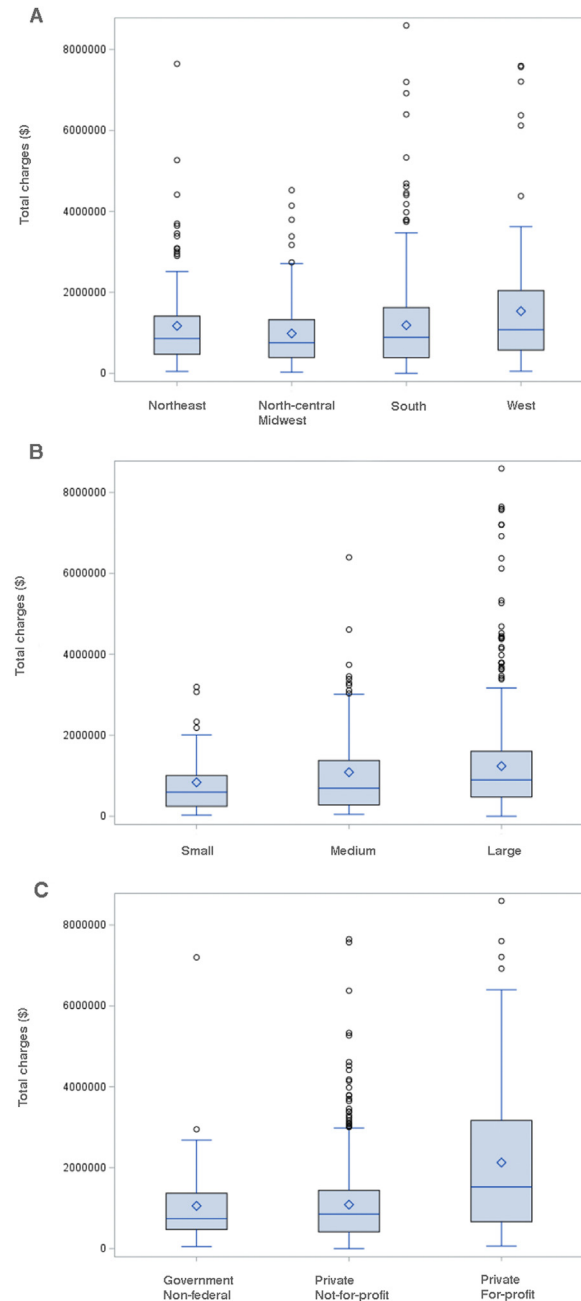


Fig 2. Box and whisker plots showing hospitalization charges by region (A), hospital bed size (B), and hospital for-profit status (C).

(53.7%), and large (54.0%). Survival to discharge by for-profit status was nonfederal government (38.9%), private not-for-profit (56.0%), and private for-profit (58.6%).

Discussion

In a retrospective cohort study using data from the 2020 NIS, 3,315 patients with COVID-19 who were treated with VV ECMO were evaluated. Overall survival to hospital discharge was 54.6%, which was nearly identical to what the Extracorporeal Life Support Organization reported for >16,500 patients with COVID-19 treated with VV ECMO (53%) during the pandemic.¹ The median hospitalization cost

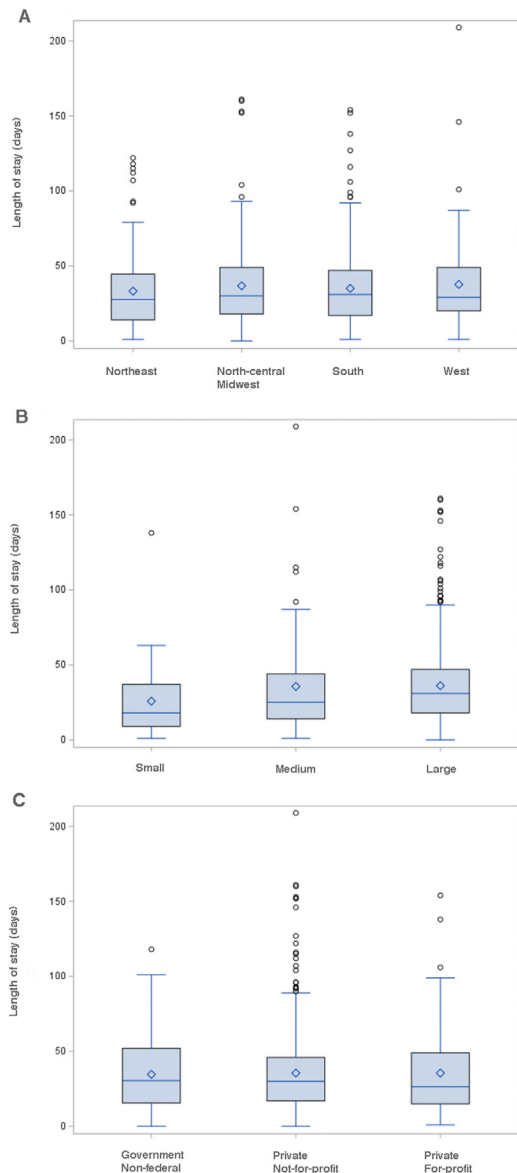


Fig 3. Box and whisker plots showing length of hospital stay by region (A), hospital bed size (B), and hospital for-profit status (C).

for patients in this study cohort was \$200,300; the median charge was \$868,790; and the median length of hospital stay was 30 days. Hospitalization charges and lengths of hospital stay for patients with COVID-19 were similar to what Hayanga et al. previously reported for patients treated with VV ECMO without COVID-19 (mean hospital charges = \$832,786 and mean length of hospital stay = 29 days) from 2008 to 2016.⁷ Hospitalization costs and charges differed significantly by hospital region, bed size, and for-profit status. Lengths of hospital stay also differed by hospital region and bed size.

Venovenous ECMO was used extensively during the COVID-19 pandemic to support patients with severe ARDS from COVID-19. Although there are no randomized controlled trials to support its efficacy in patients with severe COVID-19, at least 1 large observational study that used causal inference techniques to control for confounding suggested that VV

ECMO reduced mortality by 7% in patients with severe ARDS from COVID-19.⁸ Multiple studies have suggested that patients with COVID-19 on VV ECMO had longer ECMO courses, more complications, and higher mortality than patients without COVID-19 treated with VV ECMO.⁹ Interestingly, the present study analysis found that the median hospitalization cost for patients treated with VV ECMO was similar to what has been reported previously, approximately \$200,000 per patient. In a recent systematic review, which included 14 studies from the United States, the mean ECMO cost was between \$50,000 and \$300,000 per patient, depending on the individual study.⁶

Patients who were treated with VV ECMO for non-COVID-19-related respiratory failure during 2020 had lower costs, charges, and shorter median length of hospital stay compared with what Hayanga et al. reported from 2008 to 2016, although Hayanga et al. reported mean values.⁷ This could be in part because patients without COVID-19 treated with VV ECMO during the pandemic were lower risk. The number of influenza cases fell dramatically during the COVID-19 pandemic, and limited additional VV ECMO resources were available in many centers. This may have led ECMO centers with limited resources to select patients without COVID-19 with the highest likelihood of survival and lowest likelihood of a long ECMO run.¹⁰

Hospital charges are typically several-fold higher than hospital costs. Individual hospitals have a “chargemaster,” which lists the prices of procedures and supplies in their hospital.¹¹ Historically, most hospitals did not report their chargemaster to the public; however, in 2021, the United States government passed hospital price transparency rules requiring hospitals to report their chargemaster.¹² Currently, half of United States hospitals comply with this regulation.¹² To the authors’ knowledge, this study was one of the first to report differences in hospitalization costs and charges for patients with COVID-19 treated with VV ECMO in various hospitals.

Hospitals rarely are reimbursed the full amount they charge by the Centers for Medicare and Medicaid Services or private insurers. Instead, they receive discounted or negotiated reimbursements based on the patients’ diagnosis-related group. Historically, for-profit hospitals have charged more for the same medical services and have received higher reimbursement.¹³⁻¹⁵ There are potential explanations for this, which include the need to pay income tax (which not-for-profit hospitals do not), differences in technology, differences in staffing, and the desire to achieve higher profit margins for shareholders. In this study, for-profit hospitals had the lowest cost of care and highest charges, which suggested the largest financial margin. It is difficult to know whether for-profit hospitals’ lower cost of care was related to differences in patient acuity, care efficiency, or avoidance of expensive therapies.

Patients treated in large hospitals had higher costs of care, higher charges, and longer hospital stays. This probably, in part, reflected higher acuity. However, these differences also may reflect the use of more expensive technology or services only available in large hospitals. Higher care costs in large

hospitals are almost certainly related to longer hospital stays, which the present data confirmed to be true. The median length of hospital stay in large hospitals was almost twice that of small hospitals. It is possible that large hospitals allowed patients to stay on ECMO longer because they were considering advanced therapies such as lung transplantation, which a small number of patients in this study cohort received. Alternatively, large hospitals may have been less efficient at discharging patients home or to rehabilitation or skilled nursing facilities.

Nonfederal government hospitals had markedly lower survival to hospital discharge in this study (about 39%). The reason for lower survival to discharge was not clear, but possible explanations include lower quality, less experience with ECMO, higher patient acuity, or perhaps reduced capacity to care for multiple critically ill patients with COVID-19 during the pandemic. Hospitals that were highly “strained” during the COVID-19 pandemic had excess mortality, and government hospitals frequently care for the underserved, who cannot access healthcare in other hospitals.^{16,17}

Most patients with COVID-19 on ECMO in this study were men (69%), which was consistent with prior trends in extracorporeal life support, in which men appeared to be more common to receive ECMO than women.^{18,19} There could be multiple reasons for this finding, including conscious and unconscious biases in ECMO use, differing attitudes about ECMO between men and women, and a disproportionate effect of COVID-19 on men and women. During the COVID-19 pandemic, men were both more likely to have severe COVID-19 and also to die from COVID-19.^{20,21}

This study had limitations. First, the NIS does not contain granular data on individual patients’ ECMO courses, including the number of ECMO days. Similarly, it is challenging to perform illness severity adjustment, accounting for all complications (eg, blood transfusion, refractory hypoxemia) and use of different ECMO technologies. These factors almost certainly affected the costs of care, charges, and lengths of hospital stay. Second, the NIS contains data for 20% of all hospitalizations in the United States, and the full cohort presented here was estimated using discharge weights in the NIS. Third, these data may not be generalizable to ECMO practices outside the United States, where healthcare delivery differs. Fourth, there were no data for all years of the COVID-19 pandemic. The NIS currently only contains data for patients with COVID-19 from 2020. Fifth, costs and charges for inflation were not adjusted. Finally, some patients may have been on VV ECMO initially for non-COVID–related illness and subsequently developed COVID-19.

Conclusions

In summary, in a retrospective cohort study of 3,315 patients with COVID-19 treated with VV ECMO during 2020, patients appeared to have similar hospitalization costs, charges, and lengths of hospital stay compared to previously reported for patients without COVID-19 treated with VV ECMO in the United States. The highest costs of care and longest hospital stays were observed in large hospitals. For-profit hospitals had the

lowest cost of care and highest charges, although survival to discharge was similar between private not-for-profit and for-profit hospitals. Notably, there were >3,000 non–COVID-19–related VV ECMO runs during the same period. These patients appeared to represent a lower-risk group with lower hospitalization costs, charges, and shorter lengths of hospital stay than previously reported for patients treated with VV ECMO. Further studies are needed to fully understand the costs and economics of VV ECMO care during the COVID-19 pandemic.

Conflict of Interest

None.

Supplementary materials

Supplementary material associated with this article can be found in the online version at doi:10.1053/j.jvca.2023.04.001.

References

- 1 Extracorporeal Life Support Organization (ELSO), ELSO COVID-19 Registry Dashboard. Available at: <https://www.elso.org/registry/elsoliveregistrydashboard.aspx>. Accessed March 1, 2023.
- 2 Dave SB, Rabinowitz R, Shah A, et al. COVID-19 outcomes of venovenous extracorporeal membrane oxygenation for acute respiratory failure vs historical cohort of non-COVID-19 viral infections [e-pub ahead of print]. *Perfusion*. <https://doi.org/10.1177/02676591221105603>. Accessed May 1, 2023.
- 3 Kakar V, North A, Bajwa G, et al. Long runs and higher incidence of bleeding complications in COVID-19 Patients requiring venovenous extracorporeal membrane oxygenation: A case series from the United Arab Emirates. *Indian J Crit Care Med* 2021;25:1452–8. <https://doi.org/10.1053/j.jvca.2023.04.001>.
- 4 Yusuff H, Zochios V, Brodie D. Thrombosis and coagulopathy in COVID-19 patients receiving ECMO: A narrative review of current literature. *J Cardiothorac Vasc Anesth* 2022;36:3312–7.
- 5 Mansour A, Flecher E, Schmidt M, et al. Bleeding and thrombotic events in patients with severe COVID-19 supported with extracorporeal membrane oxygenation: A nationwide cohort study. *Intensive Care Med* 2022; 48:1039–52.
- 6 Oude Lansink-Hartgring A, van Minnen O, Vermeulen KM, et al. Hospital costs of extracorporeal membrane oxygenation in adults: A systematic review. *Pharmacoecoon Open* 2021;5:613–23.
- 7 Hayanga JWA, Aboagye J, Bush E, et al. Contemporary analysis of charges and mortality in the use of extracorporeal membrane oxygenation: A cautionary tale. *JTCVS Open* 2020;1:61–70.
- 8 Urner M, Barnett AG, Bassi GL, et al. Venovenous extracorporeal membrane oxygenation in patients with acute COVID-19 associated respiratory failure: Comparative effectiveness study. *BMJ* 2022;377:e068723.
- 9 Aljishi RS, Alkuaibi AH, Al Zayer FA, et al. Extracorporeal membrane oxygenation for COVID-19: A systematic review. *Cureus* 2022;14:e27522.
- 10 Rubin R. Influenza’s unprecedented low profile during COVID-19 pandemic leaves experts wondering what this flu season has in store. *JAMA* 2021;326:899–900.
- 11 Reinhardt UE. The pricing of U.S. hospital services: Chaos behind a veil of secrecy. *Health Aff (Millwood)* 2006;25:57–69.
- 12 Haque W, Ahmadzada M, Allahrakha H, et al. Transparency, accessibility, and variability of US hospital price data. *JAMA Netw Open* 2021;4:e2110109.
- 13 Woolhandler S, Himmelstein DU. The high costs of for-profit care. *CMAJ* 2004;170:1814–5.

- 14 Devereaux PJ, Heels-Ansdell D, Lacchetti C, et al. Payments for care at private for-profit and private not-for-profit hospitals: A systematic review and meta-analysis. *CMAJ* 2004;170:1817–24.
- 15 Jeurissen PPT, Kruse FM, Busse R, et al. For-profit hospitals have thrived because of generous public reimbursement schemes, not greater efficiency: A multi-country case study. *Int J Health Serv* 2021;51:67–89.
- 16 French G, Hulse M, Nguyen D, et al. Impact of hospital strain on excess deaths during the COVID-19 pandemic—United States, July 2020-July 2021. *Am J Transplant* 2022;22:654–7.
- 17 Block BL, Martin TM, Boscardin WJ, et al. Variation in COVID-19 mortality across 117 US hospitals in high- and low-burden settings. *J Hosp Med* 2021;16:215–8.
- 18 Ting PS, Chen L, Yang WC, et al. Gender and age disparity in the initiation of life-supporting treatments: A population-based cohort study. *BMC Med Ethics* 2017;18:62.
- 19 Wang AS, Nemeth S, Kurlansky P, et al. Sex differences in patients with cardiogenic shock requiring extracorporeal membrane oxygenation. *J Thorac Cardiovasc Surg* 2022;164:960–9.
- 20 Qi S, Ngwa C, Morales Scheihing DA, et al. Sex differences in the immune response to acute COVID-19 respiratory tract infection. *Biol Sex Differ* 2021;12:66.
- 21 Jin JM, Bai P, He W, et al. Gender differences in patients with COVID-19: Focus on severity and mortality. *Front Public Health* 2020;8:152.