

Alejandro A. Diaz, M.D.  
Brigham and Women's Hospital and Harvard Medical School  
Boston, Massachusetts

Lloyd L. Liang, M.S.  
Igor Barjaktarevic, M.D., Ph.D.  
Richard N. Channick, M.D.  
University of California, Los Angeles  
Los Angeles, California

Raúl San José Estépar, Ph.D.  
George R. Washko, M.D.  
Brigham and Women's Hospital and Harvard Medical School  
Boston, Massachusetts

Rajan Saggari, M.D.\*  
University of California, Los Angeles  
Los Angeles, California

ORCID IDs: 0000-0003-0419-9670 (F.N.R.); 0000-0001-5037-2919 (A.A.D.); 0000-0002-3677-1996 (R.S.J.E.).

\*Corresponding author (e-mail: rsaggari@mednet.ucla.edu).

## References

- Fernandez-Bonetti P, Lupi-Herrera E, Martinez-Guerra ML, Barrios R, Seoane M, Sandoval J. Peripheral airways obstruction in idiopathic pulmonary artery hypertension (primary). *Chest* 1983;83:732–738.
- Meyer FJ, Ewert R, Hoepfer MM, Olschewski H, Behr J, Winkler J, et al. Peripheral airway obstruction in primary pulmonary hypertension. *Thorax* 2002;57:473–476.
- Laveneziana P, Humbert M, Godinas L, Joureau B, Malrin R, Straus C, et al. Inspiratory muscle function, dynamic hyperinflation and exertional dyspnoea in pulmonary arterial hypertension. *Eur Respir J* 2015;45:1495–1498.
- Boucly A, Morélot-Panzini C, Garcia G, Weatherald J, Jaïs X, Savale L, et al. Intensity and quality of exertional dyspnoea in patients with stable pulmonary hypertension. *Eur Respir J* 2020;55:1802108.
- Rahaghi FN, Nardelli P, Harder E, Singh I, Sanchez-Ferrero GV, Ross JC, et al. Quantification of arterial and venous morphological markers in pulmonary arterial hypertension using computed tomography. *Chest* [online ahead of print] 13 Jul 2021; DOI: 10.1016/j.chest.2021.06.069.
- San Jose Estepar R, Ross JC, Harmouche R, Onieva J, Diaz AA and Washko GR. Chest Imaging Platform: an open-source library and workstation for quantitative chest imaging [abstract]. *Am J Respir Crit Care Med* 2015;191:A4975.
- Schroeder JD, McKenzie AS, Zach JA, Wilson CG, Curran-Everett D, Stinson DS, et al. Relationships between airflow obstruction and quantitative CT measurements of emphysema, air trapping, and airways in subjects with and without chronic obstructive pulmonary disease. *AJR Am J Roentgenol* 2013;201:W460–70.
- McNitt-Gray MF, Goldin JG, Johnson TD, Tashkin DP, Aberle DR. Development and testing of image-processing methods for the quantitative assessment of airway hyperresponsiveness from high-resolution CT images. *J Comput Assist Tomogr* 1997;21:939–947.
- Diaz AA, Young TP, Maselli DJ, Martinez CH, Maclean ES, Yen A, et al. Bronchoarterial ratio in never-smokers adults: Implications for bronchial dilation definition. *Respirology* 2017;22:108–113.
- Quanjer PH, Stanojevic S, Cole TJ, Baur X, Hall GL, Culver BH, et al. Multi-ethnic reference values for spirometry for the 3–95-yr age range: the global lung function 2012 equations. *Eur Respir J* 2012;40:1324–1343.
- Sandhu G, Sharma D, Rajdev K, Habib S, El-Sayegh D. Bronchial obstruction caused by a dilated pulmonary artery. *Cureus* 2019;11:e5354.
- Saha BK, Beegle S. Central airway compression by massively dilated pulmonary artery in a patient with pulmonary arterial hypertension: a rare entity. *BMJ Case Rep* 2019;12:e232468.
- Rajaram S, Swift AJ, Condliffe R, Johns C, Elliot CA, Hill C, et al. CT features of pulmonary arterial hypertension and its major subtypes: a systematic CT evaluation of 292 patients from the ASPIRE Registry. *Thorax* 2015;70:382–387.

Copyright © 2021 by the American Thoracic Society



## Evaluating Approaches to Improve Equity in Critical Care Resource Allocation in the COVID-19 Pandemic

To the Editor:

The coronavirus disease (COVID-19) pandemic has forced healthcare systems to develop strategies to allocate critical care resources when demand outstrips supply (1). The pandemic has also disproportionately impacted Black patients (2, 3), for whom baseline health disparities are well documented and largely driven by inequity in social determinants of health. Concerns about the potential for inequity in resource allocation were raised early in the pandemic, especially if morbidity limiting near-term survival was factored into allocation decisions. Two mitigation strategies to avoid inequity in allocation have been proposed: eliminating consideration of expected survival beyond 1 year and incorporating measures of social disadvantage such as the Area Deprivation Index (ADI) (2, 4, 5).

Few studies have empirically evaluated the potential impact of allocation frameworks on disparities, and none have assessed the impact of these proposed modifications. We analyzed the distribution of allocation scores by patient race and modeled the impact of proposed modifications at four academic hospitals in Atlanta, Georgia.

## Methods

We obtained data on adult non-Hispanic White (NHW) and Black (NHB) ICU patients admitted between September 1, 2020, and January 8, 2021, to four academic hospitals. For patients with multiple admissions, only the first was included. This study was approved by the Emory Institutional Review Board as part of the COVID-19 Quality and Clinical Research Collaborative.

Allocation scores were derived from three components.

1) Sequential Organ Failure Assessment (SOFA): defined as the maximum score the day of ICU admission. 2) Underlying Conditions Question (UCQ): for every patient, attending physicians were asked to assess whether the patient's expected 1- or 5-year mortality was >50% based on preexisting medical conditions (independent of acute illness causing hospitalization). 3) ADI: the ADI ranks census blocks by socioeconomic disadvantage, ranging from 1 (least disadvantage) to 10 (most) (6).

This article is open access and distributed under the terms of the Creative Commons Attribution Non-Commercial No Derivatives License 4.0. For commercial usage and reprints, please e-mail Diane Gern (dgern@thoracic.org).

Author Contributions: All authors fulfill International Committee of Medical Journal Editors criteria for authorship.

Originally Published in Press as DOI: 10.1164/rccm.202106-1462LE on October 8, 2021

**Table 1.** Demographic Characteristics of ICU Admissions to Four Emory Hospitals between September 1, 2020, and January 15, 2021

	Non-Hispanic White (n = 1,514)	Non-Hispanic Black (n = 1,732)	Overall (N = 3,246)	P Value
Age, yr, mean (SD)	64.9 (16.1)	59.0 (15.3)	61.7 (16.0)	<0.001
Sex, n (%)				<0.001
F	671 (44.3)	902 (52.1)	1,573 (48.5)	
M	843 (55.7)	830 (47.9)	1,673 (51.5)	
ADI, mean (SD)	3.28 (2.49)	4.89 (2.35)	4.14 (2.55)	<0.001
ADI ≥8, n (%)				<0.001
Yes	132 (8.7)	249 (14.4)	381 (11.7)	
No	1,382 (91.3)	1,483 (85.6)	2,865 (88.3)	
UCQ, n (%)				0.42
0	827 (54.6)	982 (56.7)	1,809 (55.7)	
2	438 (28.8)	544 (31.4)	1,033 (31.8)	
4	198 (13.1)	206 (11.9)	404 (12.4)	
SOFA, mean (SD)	5.93 (4.27)	6.18 (4.30)	6.07 (4.29)	0.10
SOFA score category, n (%)				0.44
<6	771 (50.9)	841 (48.6)	1,612 (49.7)	
6, 7, or 8	344 (22.7)	392 (22.6)	736 (22.7)	
9, 10, or 11	222 (14.7)	280 (16.2)	502 (15.5)	
≥12	177 (11.7)	219 (12.6)	396 (12.2)	
Allocation score, mean (SD)				
Original	3.04 (1.96)	3.03 (1.87)	3.03 (1.91)	0.91
ADI	2.95 (1.99)	2.89 (1.90)	2.91 (1.94)	0.35
Mortality	2.39 (1.84)	2.40 (1.78)	2.40 (1.81)	0.87
Combined	2.31 (1.87)	2.26 (1.81)	2.28 (1.84)	0.48

Definition of abbreviations: ADI = Area Deprivation Index; SOFA = Sequential Organ Failure Assessment; UCQ = Underlying Conditions Question.

We considered four allocation frameworks, adapted from criteria commonly used in state triage guidelines (7). The first (“Original”) prioritized saving lives (defined by surviving the admission) and life-years (defined by survival after discharge). The allocation score is a combination of points derived from the SOFA score and the UCQ score and ranges from 1 to 8. SOFA scores were assigned point values as follows: 1 (<6), 2 (7–8), 3 (9–11), and 4 (>12). Patients with >50% estimated probability of death from preexisting conditions within 1 year received a UCQ score of 4, and those with >50% probability of death within 5 years received a UCQ score of 2. Lower allocation scores would receive a higher priority for resource allocation.

The second framework removes consideration of 5-year mortality (“Mortality”). Patients with >50% estimated probability of death from preexisting conditions within 1 year received a UCQ score of 4; all others received a score of 0. The third framework (“ADI”) subtracts 1 point from the overall score for patients living in a neighborhood with an ADI ≥8. The fourth framework combines both “Mortality” and “ADI” modifications (“Combined”).

If allocation became necessary, decisions would be made for patients above score thresholds determined by the degree of resource scarcity. We described patient characteristics by race and modeled allocation score distribution using thresholds from 1 (most resource scarcity) to 7 (least resource scarcity). We tested for differences in proportion of scores above each threshold by race for each framework using chi-square tests.

## Results

Among the included 3,246 ICU patients, 53.4% were NHB (Table 1). The proportion of NHB patients in the ICU was consistent with overall admissions to the hospital during the study period (53.3%

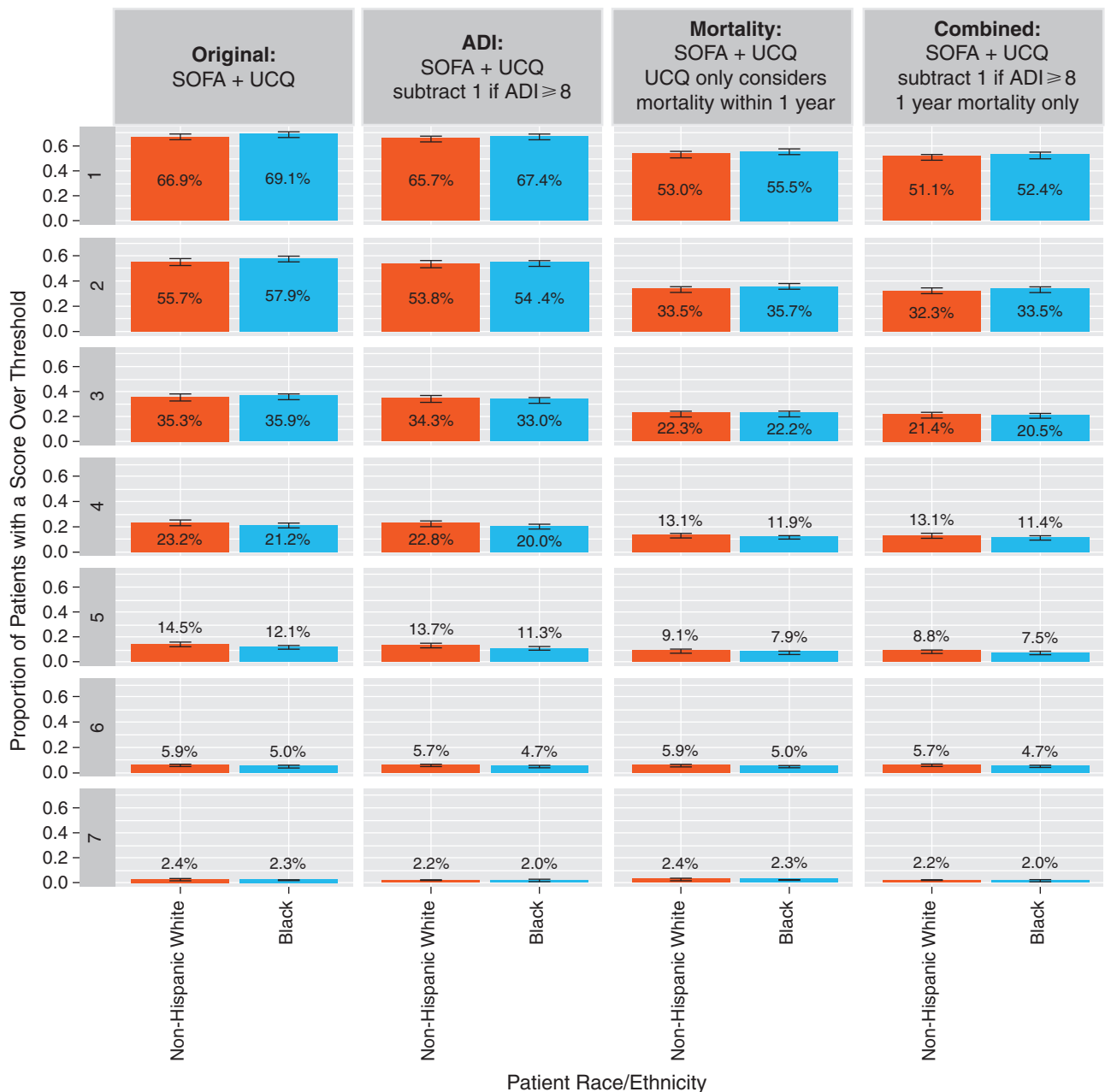
NHB). NHB patients were younger, were more likely to be female and had a higher mean ADI than NHW patients. More than half had no underlying conditions expected to limit near-term mortality (55.7%); 49.7% had maximum SOFA <6.

There were similar proportions of NHB and NHW patients with scores above each threshold (Figure 1). For each framework, NHB patients had a higher proportion of scores above 1 or 2. A higher proportion of NHW patients had a score above threshold at a threshold of 3 or higher. The absolute value of the difference between groups was small (0–2.2 percentage points). At a threshold score of 3, adjusting for ADI would result in 16 NHW and 49 NHB patients moving below the threshold into the higher priority group, whereas dropping the 5-year mortality consideration would result in 197 NHW and 236 NHB patients moving into the high priority group. There were no statistically significant differences by race for any framework or threshold. Results were similar when stratified by age above or below 65 (not shown).

## Discussion

Concerns exist that allocation frameworks aimed at saving the most life-years by prioritizing individuals without preexisting conditions limiting near-term survival could exacerbate systemic disparities in health and healthcare in the United States (2). In this analysis of ICU patients across a healthcare system, absolute differences in allocation scores by race were small and not statistically significant. Proposed modifications to allocation frameworks to improve equity did not meaningfully impact the racial distribution of scores.

A strength of this study is that it includes all diagnoses and real-world physician assessments of underlying conditions. Prior work has involved simulated assessments (8) or has focused on patients with



**Figure 1.** Proportion of ICU patients above specified allocation cutoffs, by patient race. ADI = Area Deprivation Index; SOFA = Sequential Organ Failure Assessment; UCQ = Underlying Conditions Question.

specific diagnoses (9), but allocation systems are not diagnosis specific. This analysis is also not specific to any one critical care resource, although it is most directly applicable to ICU beds, a resource for which significant concern about scarcity exists.

This analysis does have limitations. We were unable to model real-time use of these systems to distinguish between discrete, sequentially presenting individual patients who may compete for the same resource at a given time. Related, we were unable to model tie-breaking criteria such as significant age differences and essential worker status that may have equity-promoting characteristics (4, 10). The UCQ was not mandatory,

and 36.6% of patients were missing data, although data were not missing differentially by race. We also did not explore adjustment tools for socioeconomic disadvantage other than dichotomized ADI. A sensitivity analysis of different ADI weighting did not reveal a significant impact, but other adjustment methods or thresholds may be more impactful. Finally, results may not be generalizable to other patient populations. Corrections designed to improve equity could have a larger impact in populations with greater disadvantage or stronger associations between race and area-level disadvantage or disparities in underlying conditions scores.

In summary, we did not find significant racial differences in allocation scores using an allocation system based on ethical principles commonly used in state triage guidelines, and proposed equity-promoting modifications did not meaningfully impact racial distribution of allocation scores at four hospitals in Atlanta, Georgia. Our analysis underscores the need for empirical evaluation of allocation frameworks as they would be implemented and of proposed modifications to improve equity. It also reaffirms the need for continued research addressing resource allocation equity. ■

**Author disclosures** are available with the text of this letter at [www.atsjournals.org](http://www.atsjournals.org).

Katherine Ross-Driscoll, Ph.D., M.P.H.  
 Gregory Esper, M.D., M.B.A.  
 Kathy Kinlaw, M.Div.  
 Yi-Ting Hana Lee, M.P.H.  
 Alanna A. Morris, M.D.  
 David J. Murphy, M.D., Ph.D.  
 Rebecca D. Pentz, Ph.D.  
 Chad Robichaux, M.P.H.  
 Gerard Vong, D.Phil.  
 Emory University School of Medicine  
 Atlanta, Georgia

Kevin Wack, J.D., M.A.  
 Emory Healthcare  
 Atlanta, Georgia

Neal W. Dickert, M.D., Ph.D.\*  
 Emory University School of Medicine  
 Atlanta, Georgia

ORCID ID: 0000-0003-4415-3861 (N.W.D.).

\*Corresponding author (e-mail: [njr@emory.edu](mailto:njr@emory.edu)).

## References

- National Academies of Sciences, Engineering, and Medicine. Rapid expert consultation on crisis standards of care for the COVID-19 pandemic (March 28, 2020). Washington, DC: National Academies Press; 2020 [accessed 2021 May 4]. Available from: <https://www.nap.edu/catalog/25765/rapid-expert-consultation-on-crisis-standards-of-care-for-the-covid-19-pandemic-march-28-2020>.
- Cleveland Manchanda E, Couillard C, Sivashanker K. Inequity in crisis standards of care. *N Engl J Med* 2020;383:e16.
- Schmidt H. Vaccine rationing and the urgency of social justice in the Covid-19 response. *Hastings Cent Rep* 2020;50:46–49.
- White DB, Lo B. Mitigating inequities and saving lives with ICU triage during the COVID-19 pandemic. *Am J Respir Crit Care Med* 2021;203:287–295.
- Stone JR. Social justice, triage, and COVID-19: ignore life-years saved. *Med Care* 2020;58:579–581.
- University of Wisconsin School of Medicine and Public Health. 2021 [accessed 2021 May 4]. Area Deprivation Index Version 3. Available from: <https://www.neighborhoodatlas.medicine.wisc.edu/>
- University of Pittsburgh. Allocation of Scarce Critical Care Resources During a Public Health Emergency. 2020 [accessed 2021 May 4]. Available from: [https://ccm.pitt.edu/sites/default/files/UnivPittsburgh\\_ModelHospitalResourcePolicy\\_2020\\_04\\_15.pdf](https://ccm.pitt.edu/sites/default/files/UnivPittsburgh_ModelHospitalResourcePolicy_2020_04_15.pdf).
- Gershengorn HB, Holt GE, Rezk A, Delgado S, Shah N, Arora A, et al. Assessment of disparities associated with a crisis standards of care resource allocation algorithm for patients in 2 US hospitals during the COVID-19 pandemic. *JAMA Netw Open* 2021;4:e214149.
- Ashana DC, Anesi GL, Liu VX, Escobar GJ, Chesley C, Eneanya ND, et al. Equitably allocating resources during crises: racial differences in mortality prediction models. *Am J Respir Crit Care Med* 2021;204:178–186.
- White DB, Lo B. Reply to Hick and Hanfling: social factors and critical care triage: right intentions, wrong tools. *Am J Respir Crit Care Med* 2021;204:238–239.

Copyright © 2021 by the American Thoracic Society



## An Association between Positive Airway Pressure Device Manufacturer and Incident Cancer? A Secondary Data Analysis

To the Editor:

Philips Respironics issued a voluntary recall notification for positive airway pressure (PAP) devices and ventilators on June 14, 2021, potentially affecting millions of people. The voluntary recall pertained to two issues related to the polyester-based polyurethane (PE-PUR) sound abatement foam used in some models of Philips Respironics PAP devices since 2009 (1). First, the foam might degrade into irritant particles that could enter the device's air pathway and be ingested or inhaled by a PAP user; second, the PE-PUR foam may release volatile organic compounds that a PAP user may inhale. Based on the

Supported by ICES (formerly Institute for Clinical Evaluative Sciences), which is funded by an annual grant from the Ontario Ministry of Health and Long-Term Care. This study also received funding from the Lung Health Foundation (also known as the Lung Association, Ontario), Grant-in-Aid, the American Thoracic Society Foundation Unrestricted Grant, 2020 CHEST Foundation Research Grant in Sleep Medicine, the Ottawa Hospital Sleep Walk, and the University of Ottawa Department of Medicine Developmental Research Grant. Parts of this material are based on data and information compiled and provided by the Canadian Institute for Health Information and Cancer Care Ontario. The analyses, conclusions, opinions, and statements expressed herein are solely those of the authors and do not reflect those of the funding or data sources; no endorsement is intended or should be inferred. M.P. was supported by the Academic Medical Association of Southwestern Ontario. A.M. was supported by the NHLBI. T.K. is supported by the 2020 Physicians' Services Inc. (PSI) Graham Farquharson Knowledge Translation Fellowship Award. D.I.M. is supported by The Ottawa Hospital Anesthesia Alternate Funds Association and a Ottawa research chair.

Author Contributions: All coauthors were involved in the following: study conception and design, interpretation of data, revising the manuscript critically for accuracy and important intellectual content, and final approval of the version to be published. T.K. was additionally involved in the drafting of the manuscript. R.T. was additionally involved in data analyses.

Data Availability: The data set from this study is held securely in coded form at ICES. Although data sharing agreements prohibit ICES from making the data set publicly available, access may be granted to those who meet prespecified criteria for confidential access, available at [www.ices.on.ca/DAS/Data](http://www.ices.on.ca/DAS/Data). The full data set creation plan and underlying analytic code are available from the authors upon request, understanding that the computer programs may rely upon coding templates or macros that are unique to ICES and therefore either are inaccessible or may require modification.

Originally Published in Press as DOI: 10.1164/rccm.202107-1734LE on September 29, 2021