CHEST

Categorized Priority Systems

A New Tool for Fairly Allocating Scarce Medical Resources in the Face of Profound Social Inequities

Tayfun Sönmez, PhD
Chestnut Hill, MA
Parag A. Pathak, PhD
Cambridge, MA
M. Utku Ünver, PhD
Chestnut Hill, MA
Govind Persad, JD, PhD
Denver, CO
Robert D. Truog, MD
Boston, MA
Douglas B. White, MD
Pittsburgh, PA

The coronavirus disease 2019 (COVID-19) pandemic has motivated medical ethicists and several task forces to revisit or issue new guidelines on allocating scarce medical resources.[1-3] Such guidelines are relevant for the allocation of scarce therapeutics and vaccines and for allocation of ICU beds, ventilators, and other life-sustaining treatments or potentially scarce interventions. Principles underlying these guidelines, like saving the most lives, mitigating disparities, reciprocity to those who assume additional risk (eg, essential workers and clinical trial participants), and equal access[4,5] may compete with one another. We propose the use of a "categorized priority system" (also known as a "reserve system") as an improvement over existing allocation methods, particularly because it may be able to achieve disparity mitigation better than other methods.

Early in the pandemic, several states adopted a single-principle priority point system (PPS) to allocate scarce ventilators, based on patients' chances of survival to hospital discharge. In contrast, White[6] developed a multi-principle PPS to accommodate multiple ethical principles. The framework is designed to promote population health outcomes by giving priority to those most likely to survive the hospitalization and to survive in the near term after hospital discharge. It is designed to promote equity by (1) giving heightened priority to essential personnel, which includes a racially and ethnically diverse group of health-care workers[7] and individuals who play a critical role in the public health response,[8] and (2) giving some priority to patients who have had the least chance to live through life's stages. Some version of a PPS is the leading mechanism for rationing ventilators in the United States. Several states, including New York and Minnesota, use a PPS as part of guidelines that predate the COVID-19 pandemic. During the current COVID-19 pandemic, at least 25 states used a PPS as part of enacted or proposed guidelines for ventilator allocation.

Although a PPS is a valuable allocation mechanism because it can incorporate multiple values, it may not be able to achieve the most ethically- compelling balance between certain values. A PPS assigns individual attributes to a numeric scale and does not handle ethical values that are not commensurable. A reliance on individual attributes also means that a PPS struggles to incorporate group-based policies, such as the mitigation of population-level health disparities, which is a pressing issue in the COVID-

AFFILIATIONS: From the Department of Economics (T. Sönmez and M. Ünver), Boston College; the Department of Economics (P. Pathak), Massachusetts Institute of Technology; the University of Denver Sturm College of Law (G. Persad); the Center for Bioethics, Harvard Medical School, and the Department of Anesthesiology, Critical Care, and Pain Medicine (R. Truog), Boston Children's Hospital; and the Department of Critical Care Medicine (D. White), Program on Ethics and Decision Making in Critical Illness, University of Pittsburgh School of Medicine.

FINANCIAL/NONFINANCIAL DISCLOSURES: The authors have reported to *CHEST* the following: G. P. made public statements related to the allocation of scarce treatments as part of disseminating prior work in this area; was funded by a Greenwall Foundation grant (Faculty Scholars Program) outside the submitted work; personal fees from the American Society of Clinical Oncology and World Health Organization outside the submitted work. D. W. was funded by an NIH grant (NHLBI K24 HL148314) while the study was being conducted; personal fees from the American Thoracic Society, personal fees from UpToDate outside of the submitted work. None declared (T. S., M. Ü., P. P., and R. T.).

CORRESPONDENCE TO: Douglas B. White, MD; e-mail: Douglas.White@pitt.edu

DOI: https://doi.org/10.1016/j.chest.2020.12.019

19 pandemic given the disproportionate death rates among Black, Hispanic/Latino, and indigenous communities.

Existing debates over prioritizing essential workers illustrate a central problem with the use of a PPS as the allocation mechanism. Several rationing guidelines endorse prioritizing essential personnel, but others hesitate out of concern that essential personnel may take all of the scarce resources under a PPS.[9-11] These difficulties can be overcome by moving beyond a PPS to a categorized priority system (CPS).

How a CPS Can Enable More Fair Allocation

A CPS divides resources into multiple categories, enabling the use of different criteria for allocation of resources within each category.[12] Category-specific criteria can reflect the balance of ethical values guiding allocation of units in the category. A CPS does not need to use uniform criteria across all categories, making it more flexible than a PPS.

CPS, which commonly are more known as reserve systems, have been used in practice. In medicine, they were adopted for allocation of deceased donor kidneys in 2014.[13] They are used in school choice systems in Boston, Chicago, and New York City, for the assignment of marathon slots in Boston and New York City, for the allocation of H-1B visas in the United States, and for affirmative action policies worldwide.[12,14-16]

CPS for Essential Personnel: A Case Study

We use a stylized example of giving heightened priority to essential personnel for the scarce therapeutic remdesivir to illustrate how a CPS can enable a wider, and potentially fairer, set of allocation options and avoid requiring decision-makers to choose between two extreme essential worker policies (Fig 1).

Suppose there are 100 courses of remdesivir available for a population of 200 patients. Eighty patients are identified as essential personnel, and 120 patients are from the general community. A task force wishes to allocate remdesivir based on clinical criteria and would also like to give some priority for essential personnel. Suppose that both patient types have an identical distribution of clinical scores. Figure 1A shows the total supply of remdesivir and the two patient types, ordered by their clinical score.

Our first scenario (Fig 1B) is a PPS based only on clinical criteria. Because we stipulate that the distribution of clinical scores is identical between the two groups, the allocation corresponds to the proportion of the two patient types in the population. Essential personnel receive $(80/200) \times 100 = 40$ courses of remdesivir, and general-community patients receive $(120/200) \times 100 = 60$.

Our second scenario (Fig 1C) is a PPS based on giving absolute priority to essential personnel and then allocating based on clinical criteria among essential personnel and also among the general community population. In this scenario, all 80 essential personnel receive treatment because their total number is less than the total number of courses available. After that, the 20 general community patients with highest priority based on clinical criteria receive courses of remdesivir.

Our third scenario (Fig 1D) is a CPS with two categories: an 80-course open category and a 20-course category for which essential personnel receive first priority. Units in the open category are allocated solely based on clinical criteria, whereas essential personnel status is considered prior to clinical criteria in the essential personnel category. Under this CPS, the first 80 courses of remdesivir are assigned by clinical score, just as all were in the first scenario. Therefore, essential personnel receive $(80/200) \times 80 = 32$ open-category courses, and general community members receive $(120/200) \times 80 = 48$ open-category courses. Next, essential personnel receive all 20 courses of remdesivir in the second category. In total, essential personnel receive $32 + 20 = 52$ courses, and general community patients receive 48 courses.

In addition to specifying categories and specifying criteria for allocation in each category, a CPS permits two other types of policy choices. One is the quantity of remdesivir assigned to each category. Figure 2 shows how the distribution of remdesivir changes as the essential personnel category increases in size from 0 to 100, with the 20 specified in our example highlighted. As the essential personnel category grows, the quantity assigned to essential personnel likewise increases from 40 to 80 courses. Figure 2 shows that a CPS can accommodate allocations that range from no essential personnel priority (used for ventilators in Minnesota and New York) to absolute essential personnel priority (used for ventilators in Michigan). A CPS can enable allocation guidelines to implement a compromise rather than being confined to extreme options.

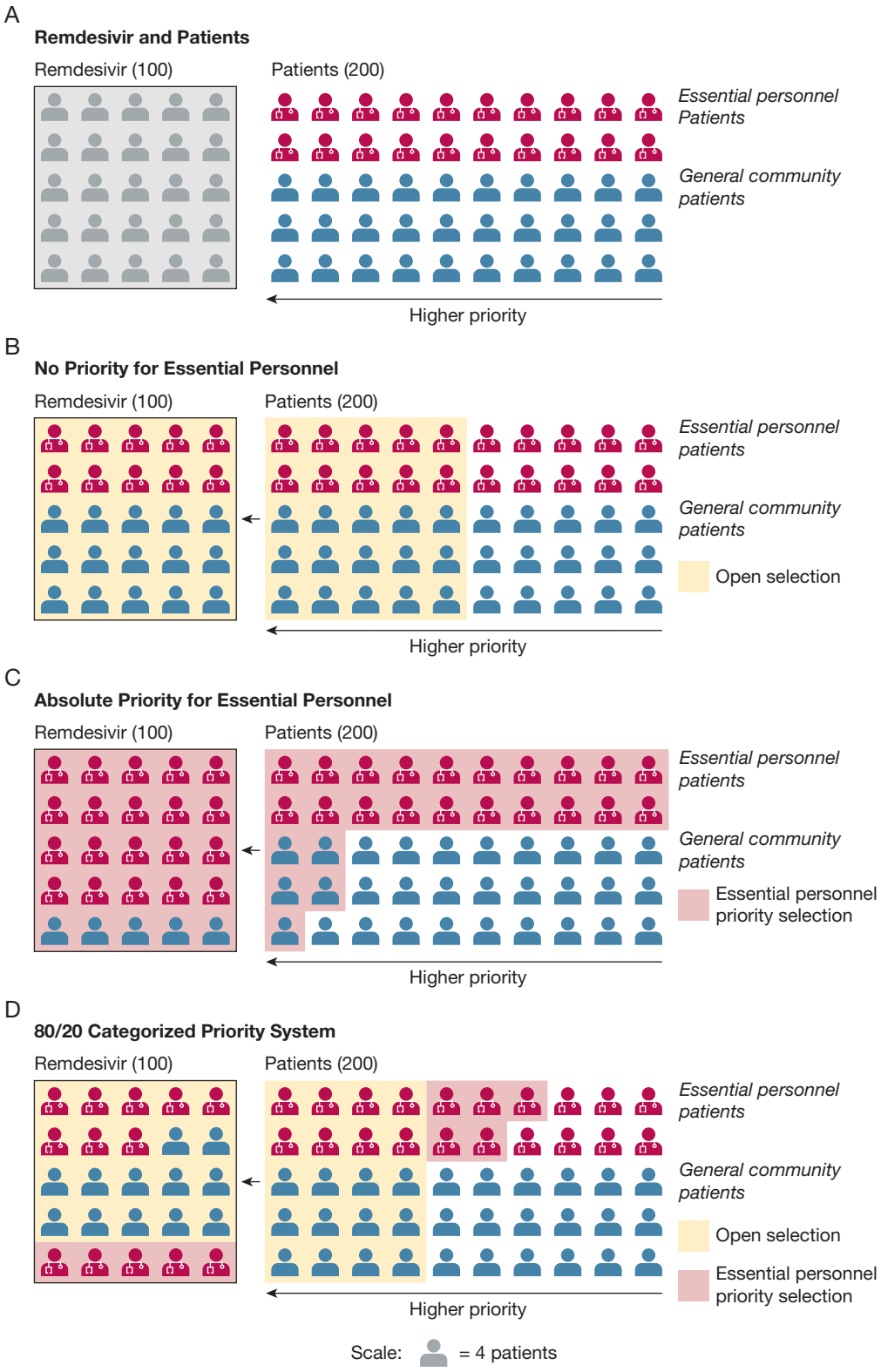

Figure 1 – *A-D, Three different allocation mechanisms: A, Remdesivir and patients; B, No priority for essential personnel; C, Absolute priority for essential personnel; D, 80/20 categorized priority system.*

The last policy choice is the order in which categories are processed. In our example, remdesivir in the open category is assigned first. However, the two categories could be processed in the opposite order. Research shows that processing the essential personnel category last provides them with the maximum benefit.[12,14,16]

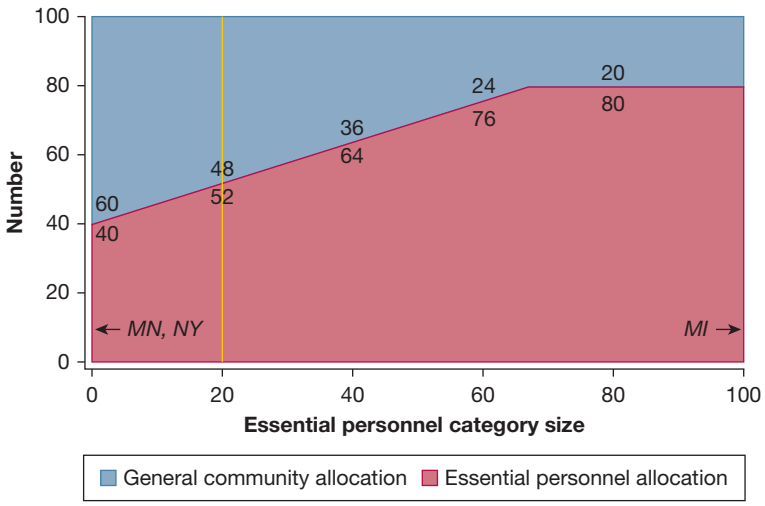

Figure 2 – *Allocation under a categorized priority system. MI = Michigan; MN = Minnesota; NY = New York.*

Using a CPS in Current Debates

A CPS can also expand the set of solutions to other key debates. Most prominent recently has been the debate over whether to incorporate disparity reduction into allocation policies.[17] Compared with alternatives like random assignment,[18] a CPS with categories for disadvantaged groups can address these concerns more effectively and can serve antiracist goals while complying with restrictions in some countries against the consideration of race at an individual level.[19] As a parallel, after the *Parents Involved* decision barred school districts in the United States from considering individual students' race, many school systems addressed educational disparities by implementing a CPS based on socioeconomic criteria: for instance, by categorizing some seats in selective enrollment high schools as preferentially accessible to qualified students from socioeconomically disadvantaged areas.[16] Using a socioeconomic index such as the Area Deprivation Index or Social Vulnerability Index to allocate treatments,[20-22] a CPS could define a disadvantaged-group category and then use clinical criteria within it, both aiming to save more lives and to ensure that disadvantaged groups are not excluded from access.

Meanwhile, many disability rights advocates fear disabilities will impact prognostication inappropriately, and some go further to reject the ethical relevance of probability or length of survival, preferring random or first-come, first-served assignment.[23,24] In this view, equal access trumps other ethical considerations. A CPS

1. **Categories**: Ethical principles or groups of patients that are deemed to have their own reserve category.
   - **Examples**: general category (includes all patients), essential personnel, patients from hard-hit areas

   A patient can be **a beneficiary** of multiple categories.
   - **Example:** All patients, including essential personnel, are beneficiaries of the general category. Essential personnel are also beneficiaries of the essential personnel category.

   ❑ **The size** of each category**:** the number of scarce treatments available in the category. The sum of all category sizes is equal to the total number of available treatments.

   ❑ **The prioritization rules**within each category:

   a. Beneficiaries of the category are ranked above non-beneficiaries.
      - **Example**: ***for essential personnel category:*** patients who are essential personnel are ranked over patients who are not essential personnel

   b. After the category is ranked by beneficiary status, beneficiaries are ranked among themselves based on a prioritization rule, as are non-beneficiaries.
      - **Examples**: ***for ventilators:***clinical prediction score followed by a random or life-cycle tiebreaker, ***for drugs without efficacy data:*** a random lottery

2. **Processing Order of Categories:** The later a category is processed, the more beneficial it is for its beneficiaries in general:
   - Processing other reserve categories **after**the general category gives them units **over and above** the general category.
   - Processing other reserve categories **before**the general category gives them a **minimum guarantee** only.

3. **Processing Algorithm:** Beginning with the first category in order, allocate the treatments reserved for the category to the patients who have the highest priority according to that category's prioritization rules. Then proceed with the next categories in order and repeat the process for the remaining patients.

Figure 3 – *Three main ingredients of a categorized priority system.*

could include a category for disabled individuals (as defined by the triage committee), with different prioritization rules for this category. This would permit patients with disabilities to achieve their desired within-group allocation without affecting the allocation criteria used for others. Similarly, a small open category with random prioritization among all patients who can benefit would provide everyone some chance of obtaining the scarce resource at issue.

Another debate involves adults and pediatric patients, between whom the metrics used to measure death risk are not readily comparable. Nevertheless, some guidelines that use a PPS assign point scores for both groups using the same index.[25] A CPS allows separate criteria for children and adults.

Operationalizing a CPS

A CPS enables allocation guidelines to use four policy levers: (1) the number and specification of categories, (2) the size of each category, (3) the rules for prioritization within each category, and (4) the order in which categories are processed (Fig 3). Although each of these levers require more detailed specification, we view this as a strength, because a CPS allows policy choices to be identified separately while a PPS necessitates the potentially more obscure translation of multiple ethical values into a single scale. There is a clear association between a category and the desired balance of ethical values for its beneficiaries. Moreover, the size of the category clearly represents the extent to which the beneficiaries of the category receive greater access. Finally, a CPS can be adjusted easily and be responsive to emerging data.

As with a PPS, decisions about these policy levers should come from community engagement exercises where citizens deliberatively examine ethical trade-offs. Community engagement seems most important for the identification of the categories and their sizes. For instance, community engagement might endorse a Good Samaritan category, which gives priority to participants in vaccine clinical trials or donors of blood, plasma, or even a kidney, based on reciprocity.[1,12] A smaller number of categories may help ensure that a CPS is transparent and practical.

Prioritization within each category, in contrast, might be based on medical factors. For example, if the community wishes to save more lives within a category, the priority rule for that category should be based on medical factors associated with survival.

Allocation experts should be enlisted to ensure that the processing order of the categories promotes the community's values, because the categories processed after the general population category will receive more resources than if they were processed before the general population category.[12] For example, the importance of recognizing essential personnel's contribution and ensuring their continued availability may warrant processing their category after the general category. In contrast, categories that aim to prevent exclusion from access should be processed before the general category. For instance, equal access may support a category for disadvantaged populations. Once this group obtains a certain share by processing their category before the general category, this minimum guarantee share can be sufficient, even if they cannot get extra units through later categories.

Conclusion

Although policymakers and clinicians have debated extensively about which ethical values should guide allocation of scarce medical resources during the pandemic, there has been comparatively little discussion of which allocation mechanism will best realize the ethical values selected. We believe an ideal allocation mechanism should permit a wide range of options for balancing different ethical values, rather than requiring a strict ordering of principles. A CPS improves on a PPS by allowing greater flexibility to balance ethical principles and ensure that allocation outcomes reflect ethical values.

Although confronting scarcity in life-and-death situations is a dire and hopefully rare possibility, allocation guidelines must balance a variety of ethical values. The limitations that a PPS faces in balancing ethical principles risk upsetting the social contract between different community members. When revising or modifying guidelines during or after the COVID-19 pandemic, a CPS should be part of the arsenal.

References

1. Emanuel EJ, Persad G, Upshur R, et al. Fair allocation of scarce medical resources in the time of Covid-19. *N Engl J Med*. 2020;382(21):2049-2055.
2. Truog RD, Mitchell C, Daley GQ. The toughest triage: allocating ventilators in a pandemic. *N Engl J Med*. 2020;382(21):1973-1975.
3. White DB, Lo B. A framework for rationing ventilators and critical care beds during the COVID-19 pandemic. *JAMA*. 2020;323(18):1773-1774.
4. Emanuel EJ, Wertheimer A; Public health. Who should get influenza vaccine when not all can? *Science*. 2006;312(5775):854-855.

5. Persad G, Wertheimer A, Emanuel EJ. Principles for allocation of scarce medical interventions. *Lancet*. 2009;373(9661):423-431.
6. White DB. A model hospital policy for allocating scarce critical care resources. Updated April 15, 2020. https://ccm.pitt.edu/sites/default/files/UnivPittsburgh_ModelHospitalResourcePolicy_2020_04_15.pdf. Accessed November 4, 2020.
7. Artiga S, Rae M, Pham O, Hamel L, Muñana C. COVID-19 risks and impacts among health care workers by race/ethnicity. KFF. 2020. https://www.kff.org/racial-equity-and-health-policy/issue-brief/covid-19-risks-impacts-health-care-workers-race-ethnicity/. Accessed November 14, 2020.
8. Rogers TN, Rogers CR, VanSant-Webb E, Gu LY, Yan B, Qeadan F. Racial disparities in COVID-19 mortality among essential workers in the United States [published online ahead of print August 5, 2020]. *World Med Health Policy*. https://doi.org/10.1002/wmh3.358.
9. Michigan. Guidelines for Ethical Allocation of Scarce Medical Resources and Services During Public Health Emergencies in Michigan. 2012. https://asprtracie.hhs.gov/technical-resources/resource/6396/guidelines-for-ethical-allocation-of-scarce-medical-resources-and-services-during-public-health-emncies-in-michigan. Accessed August 8, 2020.
10. Vawter DE, Garrett JE, Gervais KG, et al. For the good of us all: ethically rationing health resources in Minnesota in a severe influenza pandemic. Minnesota Pandemic Ethics Project, Minnesota Department of Health; 2010. https://www.health.state.mn.us/communities/ep/surge/crisis/ethics.pdf. Accessed August 8, 2020.
11. Zucker HA, Adler KP, Berens DP, et al; Ventilator allocation guidelines. New York State Task Force on Life and the Law, New York Department of Health. November 2015. https://www.health.ny.gov/regulations/task_force/reports_publications/docs/ventilator_guidelines.pdf. Accessed August 8, 2020.
12. Pathak PA, Sönmez T, Ünver MU, Yenmez MB. Fair allocation of vaccines, ventilators and antiviral treatments: leaving no ethical value behind in health care rationing. 2020; arXiv:2008.00374 [econ.TH].
13. UNOS. Revised national kidney transplant allocation system is now in effect. *December*. 2014;4. https://unos.org/news/revised-national-kidney-transplant-allocation-system-match-kidneys-effectively-improve-access-hard-match-patients/. Accessed November 8, 2020.
14. Dur U, Kominers SD, Pathak PA, Sönmez T. Reserve design: unintended consequences and the demise of Boston's walk zones. *Journal of Political Economy*. 2018;126(6):2457-2479.
15. Hafalir I, Yenmez MB, Yildirim M. Effective affirmative action in school choice. *Theoretical Economics*. 2013;8(2):325-363.
16. Dur U, Pathak PA, Sönmez T. Explicit vs statistical targeting in affirmative action: theory and evidence from Chicago's exam schools. *J Econ Theory*. 2020;187:104996.
17. Twohey M. Who gets a vaccine first? U.S. considers race in coronavirus plans, NY Times. July 16, 2020. https://www.nytimes.com/2020/07/09/us/coronavirus-vaccine.html. Accessed August 8, 2020.
18. Jones CP. Coronavirus disease discriminates. Our health care doesn't have to. Newsweek. April 7, 2020. https://www.newsweek.com/2020/04/24/coronavirus-disease-discriminates-our-health-care-doesnt-have-opinion-1496405.html. Accessed August 8, 2020.
19. Persad G. Allocating medicine fairly in an unfair pandemic. *University of Illinois Law Review*. In press.
20. Kind AJH, Buckingham WR. Making neighborhood-disadvantage metrics accessible: the Neighborhood Atlas. *N Engl J Med*. 2018;378(26):2456-2458.
21. Schmidt H. Vaccine rationing and the urgency of social justice in the COVID-19 response. *Hastings Center Report*. 2020;50(3):46-49.
22. Dasgupta S, Bowen VB, Leidner A, et al. Association between social vulnerability and a county's risk for becoming a COVID-19 hotspot: United States, June 1-July 25, 2020. *MMWR Morb Mortal Wkly Rep*. 2020;69(42):1535-1541.
23. DREDF. Preventing discrimination in the treatment of COVID-19 patients: The Illegality of Medical Rationing on the Basis of Disability, Disability Rights Education & Defense Fund. March 25, 2020. https://dredf.org/wp-content/uploads/2020/03/DREDF-Policy-Statement-on-COVID-19-and-Medical-Rationing-3-25-2020.pdf. Accessed August 8, 2020.
24. Applying HHS's guidance for states and health care providers on avoiding disability-based discrimination in treatment rationing. April 3, 2020. http://thearc.org/wp-content/uploads/2020/04/Guidance-to-States-Hospitals_FINAL.pdf. Accessed November 2, 2020.
25. Crisis standards of care, planning guidance for the COVID-19 Pandemic, Commonwealth of Massachusetts, Department of Public Health. April 7, 2020. https://www.documentcloud.org/documents/6843353-Revised-Crisis-Standards-of-Care-Planning-Guidance.html. Accessed August 8, 2020.