The Ethics of Creating a Resource Allocation Strategy During the COVID-19 Pandemic

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abstract

The coronavirus disease 2019 pandemic has affected nearly every aspect of medicine and raises numerous moral dilemmas for clinicians. Foremost of these quandaries is how to delineate and implement crisis standards of care and, specifically, how to consider how health care resources should be distributed in times of shortage. We review basic principles of disaster planning and resource stewardship with ethical relevance for this and future public health crises, explore the role of illness severity scoring systems and their limitations and potential contribution to health disparities, and consider the role for exceptionally resource-intensive interventions. We also review the philosophical and practical underpinnings of crisis standards of care and describe historical approaches to scarce resource allocation to offer analysis and guidance for pediatric clinicians. Particular attention is given to the impact on children of this endeavor. Although few children have required hospitalization for symptomatic infection, children nonetheless have the potential to be profoundly affected by the strain on the health care system imposed by the pandemic and should be considered prospectively in resource allocation frameworks.

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The coronavirus disease 2019 (COVID-19), previously named 2019 novel coronavirus and abbreviated 2019-nCoV,[1] pandemic raises weighty and urgent ethical questions affecting all patients and the clinicians who care for them. As bioethicists, we hope to provide support to our colleagues who care for children during this challenging pandemic. In particular, we will focus on the ethical issues related to resource allocation in times of shortage and offer analysis and guidance informed by new and historical literature.

During the COVID-19 pandemic, guidelines affecting the clinical care of adult and pediatric populations may overlap significantly. Likewise, many of the ethical principles relevant to resource allocation strategies and their implementation will be similar. However, ethical care of pediatric patients during a pandemic requires special consideration and is the focus of this report. Some important ethical considerations that primarily affect adult populations are not discussed in detail. We recognize that children receive health care not only from pediatricians but also from a diverse group of nonpediatrician physician and nonphysician clinicians. Accordingly, we will refer to our intended audience as pediatric clinicians. Although this article was written with specific attention to the immediate needs of clinicians during the COVID-19 pandemic, it is largely informed by previous work on scarce resource allocation and crisis medicine; many of the guiding principles offered here are applicable to other pandemics and health crises.

COVID-19 AND THE SHIFT IN THE ORIENTATION OF CLINICAL ETHICS

Amid a pandemic, real-time dashboards are needed to accurately report the number of cases and deaths because these change by the minute. As of April 22, 2020, nearly 2.6 million cases are confirmed worldwide and nearly 178 000 deaths.[2] In the United States, there are just >825 000 cases, and nearly 45 000 patients have died,[2] with most states still experiencing an exponential increase in cases and deaths. Because of limited testing, reliable data are not yet available on the number of children with confirmed COVID-19 infection, but children appear to be less susceptible to severe infection, and deaths have been rare.[3,4] Severity of illness and case fatality have been linked to advanced age and preexisting comorbidities, but severe illness and death have occurred in younger, previously healthy adults.[3,5–7]

Social and clinical efforts to limit the prevalence and morbidity of COVID-19 include social distancing and hygiene campaigns as well as the restriction of nonessential health care encounters. Surgeries and other procedures judged to be nonurgent are being deferred, and patients may not be permitted to have visitors to support them through their medical care. These changes, among others, represent a fundamental shift in priority from maximizing the outcomes of individual patients to optimizing the welfare of the community. Unfortunately, the demands of the COVID-19 pandemic have already exceeded our ability to provide sufficient numbers of diagnostic tests and adequate personal protective equipment (PPE) and may still exceed the ability of some places to provide enough ventilators, ICU beds, and health care professionals required to support the needs of patients. Participation in overt health care rationing is, therefore, likely for the first time in the lives of many clinicians. Consequently, institutions and clinical practices nationwide have needed to develop protocols to determine fair, systematic, and evidence-based methods for deciding who will receive health care resources if demand for these resources exceeds available supply. This shift reflects an abrupt and urgent transition from a usual standard of care, in which a respect for patient autonomy is prioritized and benefit to each patient is maximized, to public health crisis standards of care, in which the common good is prioritized and benefit to the community is maximized.

IMPLEMENTATION OF CRISIS STANDARDS OF CARE AND TRIAGE ACROSS INSTITUTIONS

Crisis standards of care are implemented when health care systems are so overwhelmed by a pervasive or catastrophic public health event that providing the normal, or standard, level of care to patients is impossible. In anticipation of that demand for care exceeding available resources, contingency planning is essential before implementation of crisis standards of care. Hospitals and local disaster planning committees should proactively explore and implement mechanisms to increase their ability to provide appropriate care to all patients through modifications in 3 essential areas: space, staff, and supplies. Key strategies to accomplish this include modular expansion of acute and critical care capacity in hospitals, preestablished tiered staffing models, transfer of patients to other facilities, shared ventilator and equipment protocols, and conserving, adapting, or substituting supplies.[8]

Local, state, and regional consensus on crisis procedures and standards of care is desirable because it facilitates coordination of care across systems and conservation of needed resources in a way that is consistent and standardized. Several states do have publicly available triage guidelines[9]; in Michigan, for example, they serve as general guidance,[10] and in Washington State, the call for uniformity in the triage process is more prescriptive.[11] Once it becomes necessary to implement crisis standards of care, ideally these standards are adopted simultaneously across hospitals within a region or state. Simultaneous adoption of crisis standards of care facilitates the equitable distribution of available resources across institutions and health systems. The general principle should be that no hospital in a region or state should enter crisis standards of care until all hospitals in the region or state have reached that point. Ideally, transfers of patients from hospitals at capacity to those with capacity should occur until no capacity exists in the area. This requires a regional or statewide effort to monitor the availability of beds and scarce resources across the region and assist in the movement of patients or resources.

In the United States, mechanisms and approaches for distribution of resources in times of shortage vary by state. Washington State offers one promising model. The Northwest Healthcare Response Network, in collaboration with the Washington State Department of Health, has implemented a Disaster Clinical Advisory Committee to develop clinically focused tools and planning for a disaster- or pandemic-related surge. This working group serves a monitoring and coordination function across the state during a surge response.[11] There has also been significant variation in the plans for resource conservation and distribution among different clinics and hospital systems. As a resource, organizational guidelines have been published in real time to advise clinical and organizational practice, informed by the experiences with COVID-19 in Asia and Europe. Institutions, however, are subject to different challenges regarding the medical supply chain and variable state public health responses, such as school closures and shelter-in-place ordinances.

Crisis standards of care may require that some scarce resources can only be made available to some patients, requiring triage. Triage judgments are best made by a triage team composed of a triage officer, who leads the team, and other health care providers. The application of any allocation protocol requires careful attention to the potential for bias based factors not relevant to survival or need. The best way to minimize implicit bias is to develop a process in which a triage team is blinded to all but prognostic factors that speak to likelihood of benefit and degree of need.

While the triage assessment occurs, first responders and bedside clinicians should perform the immediate stabilization of any patient needing critical care. Importantly, the triage team's decision-making should occur independent of the primary clinician caring for the individual patient. Although the clinician who has established a relationship with the patient might be the best person to inform the patient or family of the triage team's decision, a member of the triage team ideally should be available to communicate how the decision was made.

RESOURCE STEWARDSHIP AND CONSTRAINTS TO USUAL CLINICAL CARE

Referral medical centers that provide highly specialized care, treat the patients who are sickest and the most complex, and serve the needs of large geographic catchment areas will face unique ethical challenges. These issues are particularly salient for children because their specific needs are less likely to be met in community hospitals given the concentration of pediatric specialists in academic centers. Moreover, children who require specialized treatment of other conditions have needs that are not expected to diminish in frequency because of the pandemic. For instance, infants will continue to be born prematurely or with congenital anomalies requiring prompt treatment. Children will still require care for complex chronic medical illnesses, such as cystic fibrosis, sickle cell disease, cancer, and traumatic injuries.

As institutions and state governments deprioritize elective procedures and nonurgent medical care, distribute disposable and durable equipment, allocate hospital beds, and deploy health professionals to care for adults who are sick, they should remain mindful of the usual needs of the regions they serve and recognize that there will be patients who are sick who do not have COVID-19 and need specialized care. These decisions may cause conflict between institutions' duty to care for patients and their responsibility to steward resources. Institutions may be forced to revisit their commitment to provide some services if the necessary resources are too debilitating for an already strained health care system or are simply not available. NICU and PICU beds, extracorporeal membrane oxygenation (ECMO) circuits, continuous renal replacement machines, blood products, and advanced ventilators all may need to be redistributed for the purpose of preserving the most lives.

Children should not be excluded from advanced care therapies without careful consideration of their unique needs and vulnerabilities. Good contingency planning can help mitigate the effects of resource allocation and redistribution. In addition, illness severity scores should enable concurrent evaluation of patients with and without COVID-19 and support integrated, rather than siloed, resource allocation.[12]

GENERAL CONSIDERATIONS FOR THE ALLOCATION OF SCARCE RESOURCES

Historically, several models for scarce resource allocation have been developed and iteratively debated. The response to the COVID-19 pandemic is largely informed by the philosophical underpinnings of different resource allocation frameworks. We review the fundamental ethical principles of scarce resource allocation and interpret them in the context of the COVID-19 pandemic. We also acknowledge that final institutional policies will likely vary on the basis of the type and availability of the resource being allocated, institutional factors, and the local trajectory of COVID-19 cases.

There is broad agreement that frameworks for allocating scarce resources should be focused on providing the greatest benefit to the greatest number of individuals while the fewest resources are used. A fair system of allocation must be transparent and applied consistently. It is important to be mindful that socially vulnerable populations are most likely to suffer the greatest impact during public health emergencies[13,14] and to consider how medical criteria incorporated into triage algorithms may perpetuate inequities. Unfortunately, real-time observation of racial and ethnic disparities in COVID-19 cases and deaths[15,16] have served as a sobering reminder that seemingly objective health care decisions and illness severity scoring systems may perpetuate inequities by overlooking social determinants of health.[17,18] As the magnitude of racial and ethnic disparities in COVID-19 outcomes becomes apparent,[19,20] the potential for illness severity scores to amplify, rather than mitigate, health disparities for historically disadvantaged groups (which are often more burdened by the very comorbidities that impart less favorable scores, such as hypertension and chronic kidney disease) has appropriately motivated closer scrutiny of triage algorithms.[21] All patients should be treated respectfully; race, ethnicity, disability, gender, sex, religion, citizenship, social status and power, socioeconomic status, ability to pay, past use of resources, and other demographic factors should not be used in allocation decisions.

Although protocols may vary depending on the resource, scarcity, and setting, several criteria should be considered in their development.[12,22–28] Preferably, multiple criteria will be integrated into an allocation protocol because no single element incorporates every applicable moral consideration.[29] Allocations frameworks with particular relevance include (summarized in Table 1) the following:

Likelihood of benefit: Likelihood of benefit should be optimized in any allocation framework. Ideally, survival prognosis assessments should be as objective as possible by using existing, validated measures. Whether survival to hospital discharge or long-term survival (or both) should be used as the measure of benefit regarding intensive care intervention, such as ventilators (and the requisite ICU beds and clinician support) and blood products, is debatable. Although it might be argued that long-term survival ultimately may lead to a more objective benefit (in terms of optimizing life-years saved), a long-term survival framework carries the risk of discriminating against persons with shorter life spans because of underlying disease, disability, or age. In the setting of COVID-19, benefit for patients has been largely defined as short-term survival, at least regarding allocation of treatment modalities and hospital beds. However, this pandemic has also brought to light aspects of societal and public health benefits (other than survival) that need to be considered in the allocation of scarce resources and that serve purposes other than the benefit of individual patients. For example, PPE stewardship and strategic diagnostic testing serve benefits such as maintaining a healthy workforce and limiting further transmission of infection.

Greatest need: Among patients with similar likelihood of benefit, those with the greatest need (defined as most likely to suffer harm without the resource) should get first priority. For example, when 2 patients are both likely to benefit from ventilator support, the patient at greater risk of imminent respiratory failure should be prioritized.

Amount of resource required: Arguably, if 2 people carry a similar prognosis, the 1 requiring the fewest resources should be prioritized. Because of the difficulty in predicting how much of a resource might be required by a patient (eg, how long someone might remain on a ventilator), most frameworks have not included this criterion. However, in some circumstances, prioritizing patients who have a generally predictable short-term need for a scarce resource (eg, need for ventilation as a consequence of respiratory syncytial virus bronchiolitis) may be appropriate. Additionally, this framework might advantage children regarding rationed medications that are dose-reduced for pediatric use.

Persons performing vital functions: Arguably, the community benefits when persons performing vital functions during a disaster are prioritized regarding PPE, vaccines, and treatment.[12,27] These roles usually include health care workers and first responders, although the group may be expanded, depending on the community's needs, to include those working in grocery stores, food and mail delivery, and essential government services, for example. The argument for such prioritization includes the recognition that those individuals are essential to continue caring for others in the community during the crisis. In addition, prioritizing care for those individuals provides some degree of reciprocity for putting themselves in harm's way to assist others during the crisis. Furthermore, prioritization is an incentive for health care personnel to continue working even when the work is, or feels, unsafe. These compelling arguments are particularly powerful when the resource being allocated will prevent occupational harm (PPE, vaccines) or prevent rapid return of a provider who is infected to service. In many triage algorithms, those who perform vital functions are prioritized only as a way of making decisions between people with a similar likelihood of survival.

Random allocation: When all else is equal, randomization should be used to make decisions about ordering for priority. Random methods are generally considered to be fairer than prioritization of those who were first to arrive

TABLE 1 Summary of Resource Allocation Frameworks With Specific COVID-19–Related Considerations

	Overview	Limitations and Pitfalls	Special COVID-19 Considerations
Likelihood of benefit	Generally determined by survival estimates; allocate resources to those likeliest to survive	Debate about whether short-term survival or long-term survival is the better metric; long-term survival introduces potential for age- and/or disability-related bias	PPE conservation and reduction of risk of transmission to health care works could also be considered as benefits
		Benefit can also be defined in terms of other metrics of population health	Empirical data to inform COVID-19 survival estimates largely lacking
Greatest need	Allocate resources to those with most urgent or acute need	Difficult to determine objectively in real time May disproportionally allocate to patients with highest likelihood of mortality	In resource allocation algorithms, it is likely assumed that alternative treatments have already been considered for patients who are less ill
Amount of resource required	Consider the absolute number of patients who can be helped and maximize opportunities to help more patients	For wt-based resources (eg, many pharmacologic treatments), may be biased toward younger, smaller patients unfairly	Could be considered regarding anticipated duration of mechanical ventilation and requires consideration of differences between COVID-19 illness and other reasons for respiratory failure
Persons performing vital functions	Considers health care workers and other first responders for priority in resource allocation	May not consider other essential workers who assume risk of infection in other settings	Potential multiplier effect to promote population health, but providers sick enough to require such resources may be less likely to return to workforce quickly
		Potential to amplify existing societal inequities Potential threat to public trust in health care system	Potential incentive for vital workforce retention
Random allocation	Maximize fairness by forgoing all value or temporal triage weighting; distinct from first come, first served	Difficult to operationalize if patients do not present simultaneously Risks investment of resources on patients unlikely to derive tangible benefit when used as the only method of resource allocation; not recommended as a first-line method of resource allocation	Sequential (rather than simultaneous) presentation for care presents practical difficulties

because the latter tends to benefit those with knowledge and resources to seek early assistance from health care institutions, which may contribute to inequities in access and outcome.

With attention to these frameworks, there are a few guiding principles when creating new resource allocation guidelines for COVID-19. First, short-term survival (survival to discharge) is a reasonable criterion by which to prioritize resource allocation. Second, first come, first served should not be used to determine who gets a scarce resource for patients with similar prognoses because this unfairly benefits patients who have better access to health care institutions. Third, prioritization of persons performing vital functions as a discriminator between patients of equivalent priority scores in a triage algorithm is justifiable.

SPECIAL CONSIDERATIONS FOR THE ALLOCATION OF SCARCE RESOURCES IN PEDIATRIC POPULATIONS

The unique characteristics of children raise additional challenges that must be considered when balancing the needs of pediatric and adult populations. Many triage protocols are designed for adult patients for whom standardized clinical scoring methods are commonly used.[30–33] Although the vast majority of patients with COVID-19 who are critically ill are adults, children may be placed into competition with adult patients for scarce resources either because they have severe infection or because of other conditions requiring resource-intensive interventions. In addition, the surge in adult patients may overflow into emergency departments, inpatient wards, and ICUs normally designated for infants and children.

Historically, age and life stage have been frequently invoked in resource allocation ethics.[12,22,34,35] It has been argued that some priority should be given to those in earlier life stages. The basis for this prioritization criterion is a "fair innings" argument that suggests that with all other things being equal (such as prognosis and need), those who have not experienced as many life stages as others should have the opportunity to do so.[36,37] This would prioritize children over adults and younger adults over older adults, at least within similar prognostic categories. Prioritization of younger patients can also be supported by the utilitarian argument that younger patients can derive more benefit from a life-saving intervention by amortizing the return on that investment over more future years. Again, purely applied, this approach prioritizes not only children over adults but also infants over older children.

In recognition of increased mortality rates for older patients with COVID-19 (6.4% in patients >60 years of age compared with 0.32% in those <60 years of age[38]), some countries have instituted age limits for intubation for COVID-19–related respiratory failure.[39] This, however, has prompted accusations of ageism. Regional guidelines in the United States that include even such nonspecific considerations as "loss of reserves in energy, physical ability, cognition and general health"[11] have prompted lawsuits[40] appealing to federal health regulations that prohibit discrimination on the basis of age or disability.[41] The unreliable association between chronological and functional age has also raised concerns about arbitrary age cutoffs. Contrarily, community focus groups have endorsed consideration of age if not as a primary determinant for allocation then as a discriminator between patients of equivalent priority scores.[32] With recognition of the need for standardization and transparency in prioritization protocols, the degree of priority given to children should be made explicit, with an ethical justification provided. In principle, some prioritization of children over adults in situations of equivalent illness severity is morally justifiable on the basis of utility by amortizing investment in medical resources over more life-years and by virtue of the fair innings argument. However, COVID-19 already disproportionately affects those who are older, mortality rates rise substantially with age, and older individuals are more likely to suffer from comorbidities that impact likelihood of survival and illness severity scores. With a disease that already strongly favors younger age groups on the basis of likelihood of survival, further prioritizing younger age groups may be difficult to justify. Therefore, for COVID-19–specific resource allocation, we do not recommend explicit age-based prioritization; rather children, like members of the vital workforce, could be considered as an alternative to random allocation in rare situations of true clinical impasse.

A FRAMEWORK FOR BALANCING OBLIGATIONS TOWARD CHILDREN AND ADULTS

An ideal measure for estimating survival likelihood across the age spectrum would be both objective and reliably accurate. The Sequential Organ Failure System (SOFA) for adults[42] and the Pediatric Logistic Organ Dysfunction (PELOD) and Pediatric Logistic Organ Dysfunction 2 (PELOD 2) scoring systems for children,[43,44] for instance, use physical findings and laboratory data to determine the short-term prognosis of patients[32] and appear frequently in institutional and state triage guidelines. Several other quantitative metrics have been developed to assist in making decisions about prognosis, including an age-adapted SOFA score,[45] the Pediatric Risk of Mortality III score[46] for older children, and multiple iterations of the Score of Neonatal Acute Physiology and the Clinical Risk Index for Babies score for neonates.[47] Many cite the parameters, ease of calculation, and robustness of these scoring systems as evidence of their validity.[48] Whether any neonatal or pediatric illness severity score will prove to be a valid measure of prognosis in the setting of COVID-19 remains unclear; no available pediatric illness severity scoring system is validated in a public health crisis or as a triage tool.[25,33] Furthermore, the PELOD and PELOD 2 have not been validated in the NICU population, a group commonly omitted from published frameworks. Although these measures remain the best available scoring systems for prognosis, their shortcomings highlight the need for an updated large-scale triage protocol developed from quantitative analyses of patient outcomes. Because numbers of children with severe COVID-19 illness are small and because, thus far, triage algorithms for ventilator allocation have not been activated, whether some children with chronic illness and/or disability will be unfairly disadvantaged by existing prognostic scoring systems remains unknown[49]; however, such concerns are reasonable, and careful attention to disability bias remains essential to resource allocation protocols for children as for adults.

Identifying a single, simple framework to allocate ventilators and other medical resources across populations of children and adults is complicated by heterogeneity in the organization of children's hospitals and management of resources. For example, a framework for a freestanding children's hospital to share its resources with an affiliated adult hospital will differ greatly from that adopted by a children's hospital within a hospital with potentially less restrictive boundaries between pediatric and adult patients. Management of ventilator fleets also may vary greatly. Some NICUs use dedicated neonatal ventilators, which cannot be reallocated to adults; others use ventilators that function across the age spectrum and are part of a common fleet. These factors have the potential to alter how allocation protocols get applied to infants and children during a respiratory illness pandemic.

As discussed previously, infants and children arguably should receive preference in situations of a tie in priority scores on the basis of a fair innings or life stages argument. Some may reject the entire premise of subjecting children to triage protocols on the basis of a moral, rather than ethical, intuition to protect children over adults. Consider, however, a neonate or young child with a 10% chance of survival if given the needed resource. Should she be given preference over a 22-year-old woman who, with that resource, would have a 90% chance of survival? This seems counterintuitive, even to a pediatric clinician, and would also be inconsistent with the goal of saving the most lives. A fair and feasible method must be found to allocate scarce resources among all patients across the age spectrum.

Should the resource allocation system explicitly confer an advantage for children? For instance, if one gives the same prioritization score to a child with a 60% to 70% chance of survival as an adult with a 70% to 80% chance, children are slightly favored. Giving the same prioritization score to a child with a 20% chance as an adult with a 50% chance clearly favors children even more. However, it should be recognized that as systems increasingly favor patients with a lower likelihood of survival, they deviate from the goal of saving the most lives (although perhaps not from saving the most life-years). Anyone creating guidelines should do so with that understanding as well as an understanding of the inherent limitations of using different prediction tools in the same protocol.

Neonates present yet another challenge. Scoring newborns who are critically ill is difficult because one tool is not applicable to all infants in this population. The National Institutes of Health Extremely Preterm Birth Outcomes Tool could be used for those between 22 and 25 weeks' gestation,[50] but the likelihood of survival for this age group increases over the first days and weeks of life, making the tool less predictive over time; in fact, the tool was developed to inform obstetric and neonatal clinicians for prenatal counseling and decision-making, not to serve as a postnatal decision tool.[51] A number of neonatal illness severity scores, used primarily for clinical research purposes, exist, and consideration could be given to these as a parallel to SOFA and PELOD and PELOD 2 scores; importantly, these scores have not been found to be of high clinical utility and are not used in clinical practice.[52] To score newborns beyond the first few days, one might need to rely on clinical judgment regarding likelihood of survival using input from subspecialists and outcomes data for a given pathologic condition, but this strategy is prone to bias and provider variation. Comorbidities that influence neonatal survival could be used to adjust a prediction tool score, as they do for adults in other tools. However, once a system relies on clinical assessment of the likelihood of survival rather than specific clinical and laboratory data, the additional use of comorbidities to adjust the score carries the risk of double counting the effect of the comorbidity on the assigned score.

ALLOCATION OF ECMO DURING COVID-19

World Health Organization interim guidelines for the management of COVID-19–related acute respiratory distress syndrome recommend administering venovenous ECMO to eligible patients in specialized centers with sufficient case volumes to ensure clinical expertise. In general, ECMO can be a viable rescue strategy for some patients,[53] but the potential benefit and duration of ECMO support for patients with COVID-19 will require systematic, prospective investigation.

In addition, ethical challenges will affect decision-making when ECMO therapy is offered in a pandemic. In the American Pediatric Surgical Association guidelines for ECMO candidacy for neonatal and pediatric patients who are COVID-19–positive, as well as for controlled cardiac or respiratory cannulation, standard ECMO inclusion criteria are used.[54] Extracorporeal cardiopulmonary resuscitation (the implantation of venoarterial ECMO in a patient after sudden and unexpected pulseless condition attributable to cessation of cardiac mechanical activity)[55] in pediatric patients who are COVID-19–positive is discouraged especially for those with other comorbidities, septic shock, or evidence of multisystem organ failure.[54] It has been suggested that the immunologic status of patients should be incorporated when assessing ECMO candidacy because, reportedly, during ECMO, interleukin 6 concentrations were consistently elevated and were inversely correlated with survival in adults and children.[56] For patients under investigation for COVID-19 (ie, patients who are awaiting COVID-19 test results or whose test results were inconclusive), standard ECMO candidacy guidelines apply for respiratory, cardiac, and extracorporeal cardiopulmonary resuscitation. ECMO cannulation for both patients who are COVID-19–positive and patients under investigation requires careful attention to correct donning of PPE.

ECMO is a finite resource that requires investment of specialized equipment, highly and specifically trained health professionals, and large volumes of blood products. Use of ECMO during a pandemic, regardless of indication, thus warrants additional consideration when hospital resources are strained or limited.[57] These considerations may also be applied to other resource-intensive interventions for the patients who are sickest, such as continuous renal replacement therapy. We do not recommend uniform prohibition of ECMO or similar interventions during a public health crisis as a preemptive strategy to preserve resources. Considering cannulation for ECMO for infants and children who stand to benefit from it (in terms of survival or preservation of function) is appropriate, but application of resource allocation policies by a triage officer may be necessary in times of scarcity.

CODE STATUS FOR CHILDREN WITH SEVERE COVID-19 INFECTION

Code status for adults with severe COVID-19 infection has become controversial in the United States, partly on the basis of the high mortality observed among the patients who are sickest, the risk of viral transmission during resuscitation, and the use of PPE for an entire code team of providers.[58,59] Transparent and consistent approaches to code status for inpatients with COVID-19 infection are an essential component of institutional scarce resource allocation guidelines. Some have advocated for unilateral do not attempt resuscitation (DNAR) orders for all patients admitted to hospitals with COVID-19 infection (or at least for those who are severely ill).[59] It is reasonable to consider prioritizing pediatric clinician safety and PPE stewardship when a high-risk intervention has a low likelihood of success. Any justification for unilateral code status decision-making should be made explicit in hospital policies, and medical futility should not be conflated with the unique circumstances of this pandemic. If appropriate PPE is available, neither risks to the code team nor desire to conserve PPE are adequate justification for unilateral DNAR without first considering whether resuscitation is likely to successfully resuscitate the patient. However, well-established principles and processes exist for consideration of cardiopulmonary resuscitation and other extraordinary measures at the end of life and are often codified in policies regarding nonbeneficial treatment.[60] Such policies can be applied in the context of this pandemic but may require modifications on the basis of available resources. Members of the code team should never be expected to forgo appropriate donning of PPE before initiating the resuscitation. Families should be informed that resuscitation efforts might be delayed for clinical providers to don appropriate protective gear.

Although children seem less likely to become critically ill, consideration of code status for those who do also requires explicit justification. The evidence that informs decisions for adult patients is likely not applicable to children, and children with COVID-19 might have a higher likelihood of recovery after a resuscitation effort than adults with similar illness severity. Although DNAR status may be appropriate for children with COVID-19 who are critically ill with progressive hypoxemia, we do not recommend a preemptive strategy of unilateral DNAR orders for all children with severe infection.

CONCLUSIONS

In this article, we have explored several considerations in the development of an allocation protocol for distributing scarce resources during COVID-19. In these protocols, how to allocate resources across the age spectrum must be considered, and multiple criteria should be integrated to capture all medically and morally relevant values. Transparency and inclusivity in development of allocation protocols is critical to ensure that inequities are not exacerbated or perpetuated. The unique needs of children must be included in planning prospectively to prepare to meet their needs.

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ABBREVIATIONS

COVID-19: coronavirus disease 2019
DNAR: do not attempt resuscitation
ECMO: extracorporeal membrane oxygenation
PELOD: Pediatric Logistic Organ Dysfunction
PELOD 2: Pediatric Logistic Organ Dysfunction 2
PPE: personal protective equipment
SOFA: Sequential Organ Failure System

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REFERENCES

1. Centers for Disease Control and Prevention. Frequently asked questions. 2020. Available at: https://www.cdc.gov/coronavirus/2019-ncov/faq.html#anchor_1584386215012. Accessed April 4, 2020
2. Johns Hopkins University. COVID-19 Dashboard by the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University. 2020. Available at: https://coronavirus.jhu.edu/map.html. Accessed April 23, 2020
3. Dong Y, Mo X, Hu Y, et al. Epidemiology of COVID-19 among children in China. *Pediatrics*. 2020;145(6):e20200702
4. CDC COVID-19 Response Team. Severe outcomes among patients with coronavirus disease 2019 (COVID-19) - United States, February 12–March 16, 2020. *MMWR Morb Mortal Wkly Rep*. 2020;69(12):343–346
5. Zhou F, Yu T, Du R, et al. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study [published correction appears in Lancet. 2020;395(10229):1038]. *Lancet*. 2020;395(10229):1054–1062
6. Ruan Q, Yang K, Wang W, Jiang L, Song J. Clinical predictors of mortality due to COVID-19 based on an analysis of data of 150 patients from Wuhan, China [published correction appears in Intensive Care Med. 2020. doi:10.1007/s00134-020-06028-z]. *Intensive Care Med*. 2020;46(5):846–848
7. Yang X, Yu Y, Xu J, et al. Clinical course and outcomes of critically ill patients with SARS-CoV-2 pneumonia in Wuhan, China: a single-centered, retrospective, observational study [published correction appears in Lancet Respir Med. 2020;8(4):e26]. *Lancet Respir Med*. 2020;8(5):475–481
8. Daugherty-Biddison L, Gwon H, Regenberg A, Schoch-Spana M, Toner E. Maryland framework for the allocation of scarce life-sustaining medical resources in a catastrophic public health emergency. 2017. Available at: https://www.law.umaryland.edu/media/SOL/pdfs/Programs/Health-Law/MHECN/ASR%20Framework_Final.pdf. Accessed April 5, 2020
9. Baker M, Sheri F. At the top of the Covid-19 curve, how do hospitals decide who gets treatment? *The New York Times*. March 31, 2020. Available at: https://www.nytimes.com/2020/03/31/us/coronavirus-covid-triage-rationing-ventilators.html. Accessed April 21, 2020
10. State of Michigan Department of Community Health Office of Public Health Preparedness. Guidelines for ethical allocation of scarce medical resources and services during public health emergencies in Michigan. Version 2.0. Available at: https://int.nyt.com/data/documenthelper/6857-michigan-triage-guidelines/d95555bb486d68f7007c/optimized/full.pdf. Accessed April 21, 2020
11. Washington State Department of Health. Scarce resource management & crisis standards of care. 2020. Available at: https://nwhrn.org/wp-content/uploads/2020/03/Scarce_Resource_Management_and_Crisis_Standards_of_Care_Overview_and_Materials-2020-3-16.pdf. Accessed April 5, 2020
12. 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
13. Fisher M, Bubola E. As coronavirus deepens inequality, inequality worsens its spread. *The New York Times*. March 15, 2020. Available at: https://www.nytimes.com/2020/03/15/world/europe/coronavirus-inequality.html. Accessed April 5, 2020
14. Johnson A, Buford T. Early data shows African Americans have contracted and died of coronavirus at an alarming rate. 2020. Available at: https://www.propublica.org/article/early-data-shows-african-americans-have-contracted-and-died-of-coronavirus-at-an-alarming-rate. Accessed April 6, 2020
15. Khaldun JS. Racial and ethnic disparities in COVID-19 cases and deaths. 2020. Available at: https://www.michigan.gov/documents/lara/Medical_Provider_Letter_Disparities_Final_Formatted_042020_687891_7.pdf. Accessed April 21, 2020
16. Thebault R, Tran AB, Williams V. The coronavirus is infecting and killing black Americans at an alarmingly high rate. *The Washington Post*. April 7, 2020. Available at: https://www.washingtonpost.com/nation/2020/04/07/coronavirus-is-infecting-killing-black-americans-an-alarmingly-high-rate-post-analysis-shows/?arc404=true. Accessed April 21, 2020
17. Krahn GL, Walker DK, Correa-De-Araujo R. Persons with disabilities as an unrecognized health disparity population. *Am J Public Health*. 2015;105(suppl 2):S198–S206
18. Institute of Medicine Committee on Understanding and Eliminating Racial and Ethnic Disparities in Health Care. In: Smedley BD, Stith AY, Nelson AR, eds. *Unequal Treatment: Confronting Racial and Ethnic Disparities in Health Care*. Washington, DC: National Academies Press; 2003
19. Yancy CW. COVID-19 and African Americans [published online ahead of print April 15, 2020]. *JAMA*. doi:10.1001/jama.2020.6548
20. Owen WF Jr., Carmona R, Pomeroy C. Failing another national stress test on health disparities [published online ahead of print April 15, 2020]. *JAMA*. doi:10.1001/jama.2020.6547
21. Tartak JC, Khidir H. Opinion: U.S. must avoid building racial bias into COVID-19 emergency guidance. 2020. Available at: https://www.npr.org/sections/health-shots/2020/04/21/838763690/opinion-u-s-must-avoid-building-racial-bias-into-covid-19-emergency-guidance. Accessed April 21, 2020
22. Persad G, Wertheimer A, Emanuel EJ. Principles for allocation of scarce medical interventions. *Lancet*. 2009;373(9661):423–431
23. Christian MD, Sprung CL, King MA, et al; Task Force for Mass Critical Care. Triage: care of the critically ill and injured during pandemics and disasters: CHEST consensus statement. *Chest*. 2014;146(suppl 4):e61S–e74S
24. Kilner JF. *Who Lives? Who Dies? Ethical Criteria in Patient Selection*. New Haven, CT: Yale University Press; 1990
25. Committee on Guidance for Establishing Crisis Standards of Care for Use in

Disaster Situations; Institute of Medicine. *Crisis Standards of Care: A Systems Framework for Catastrophic Disaster Response*. Washington, DC: National Academies Press; 2012

26. Hick JL, Rubinson L, O'Laughlin DT, Farmer JC. Clinical review: allocating ventilators during large-scale disasters–problems, planning, and process. *Crit Care*. 2007;11(3):217

27. White DB, Lo B. A framework for rationing ventilators and critical care beds during the COVID-19 pandemic. *JAMA*. 2020;323(18):1773–1774

28. Fortes PA, Zoboli EL. A study on the ethics of microallocation of scarce resources in health care. *J Med Ethics*. 2002;28(4):266–269

29. White DB, Katz MH, Luce JM, Lo B. Who should receive life support during a public health emergency? Using ethical principles to improve allocation decisions. *Ann Intern Med*. 2009;150(2): 132–138

30. Salluh JI, Soares M. ICU severity of illness scores: APACHE, SAPS and MPM. *Curr Opin Crit Care*. 2014;20(5):557–565

31. Medlej K. Calculated decisions: sequential organ failure assessment (SOFA) score. *Emerg Med Pract*. 2018; 20(suppl 10):CD1-CD2

32. Daugherty Biddison EL, Faden R, Gwon HS, et al. Too many patients… a framework to guide statewide allocation of scarce mechanical ventilation during disasters. *Chest*. 2019;155(4):848–854

33. New York State Task Force on Life and the Law; New York State Department of Health. Ventilator allocation guidelines. 2015. Available at: https://www.health.ny.gov/regulations/task_force/reports_publications/docs/ventilator_guidelines.pdf. Accessed April 05, 2020

34. Bognar G. Fair innings. *Bioethics*. 2015; 29(4):251–261

35. Hazra NC, Gulliford MC, Rudisill C. 'Fair innings' in the face of ageing and demographic change. *Health Econ Policy Law*. 2018;13(2):209–217

36. Williams A. Intergenerational equity: an exploration of the 'fair innings' argument. *Health Econ*. 1997;6(2): 117–132

37. Harris J. *The Value of Life: An Introduction of Medical Ethics*. New York, NY: Routledge; 1985

38. Verity R, Okell LC, Dorigatti I, et al Estimates of the severity of coronavirus disease 2019: a model-based analysis [published online ahead of print March 30, 2020] [published correction appears in *Lancet Infect Dis*. Apr 15, 2020] [published correction appears in *Lancet Infect Dis*. May 4, 2020]. *Lancet Infect Dis*. 2020;S1473-3099(20)30243-7. doi:10.1016/S1473-3099(20)30243-7

39. McGrath C. Italian Hospital Makes Heartbreaking Decision Not to Intubate Anyone over the Age of 60. Available at: https://www.express.co.uk/news/world/1257852/Italy-coronavirus-intubating-elderly-pandemic-china-hospitals-Nadine-Dorries. Accessed March 20, 2020

40. Katz P. Disability discrimination complaint filed over COVID-19 treatment rationing plan in Washington State. 2020. Available at: https://thearc.org/disability-discrimination-complaint-filed-over-covid-19-treatment-rationing-plan-in-washington-state/. Accessed April 05, 2020

41. Office for Civil Rights, Office of the Secretary, US Department of Health and Human Services. Nondiscrimination in health programs and activities. Final rule. *Fed Regist*. 2016;81(96):31375-31473. Available at: https://www.federalregister.gov/documents/2016/05/18/2016-11458/nondiscrimination-in-health-programs-and-activities. Accessed April 05, 2020

42. Vincent JL, Moreno R, Takala J, et al; on behalf of the Working Group on Sepsis-Related Problems of the European Society of Intensive Care Medicine. The SOFA (sepsis-related organ failure assessment) score to describe organ dysfunction/failure. *Intensive Care Med*. 1996;22(7):707–710

43. Leteurtre S, Duhamel A, Salleron J, Grandbastien B, Lacroix J, Leclerc F; Groupe Francophone de Réanimation et d'Urgences Pédiatriques (GFRUP). PELOD-2: an update of the pediatric logistic organ dysfunction score. *Crit Care Med*. 2013;41(7):1761–1773

44. Leteurtre S, Martinot A, Duhamel A, et al. Validation of the paediatric logistic organ dysfunction (PELOD) score: prospective, observational, multicentre study. *Lancet*. 2003; 362(9379):192–197

45. Matics TJ, Sanchez-Pinto LN. Adaptation and validation of a pediatric sequential organ failure assessment score and evaluation of the Sepsis-3 definitions in critically ill children. *JAMA Pediatr*. 2017;171(10):e172352

46. Gonçalves JP, Severo M, Rocha C, Jardim J, Mota T, Ribeiro A. Performance of PRISM III and PELOD-2 scores in a pediatric intensive care unit. *Eur J Pediatr*. 2015;174(10): 1305–1310

47. Patrick SW, Schumacher RE, Davis MM. Methods of mortality risk adjustment in the NICU: a 20-year review. *Pediatrics*. 2013;131(suppl 1):S68–S74

48. Christian MD, Hawryluck L, Wax RS, et al. Development of a triage protocol for critical care during an influenza pandemic. *CMAJ*. 2006;175(11): 1377–1381

49. Savin K, Guidry-Grimes L. Confronting disability discrimination during the pandemic. 2020. Available at: https://www.thehastingscenter.org/confronting-disability-discrimination-during-the-pandemic/. Accessed April 21, 2020

50. Eunice Kennedy Shriver National Institute of Child Health and Human Development. Extremely preterm birth outcomes tool. 2020. Available at: https://www.nichd.nih.gov/research/supported/EPBO/use. Accessed April 05, 2020

51. Hornik CP, Sherwood AL, Cotten CM, Laughon MM, Clark RH, Smith PB. Daily mortality of infants born at less than 30weeks' gestation. *Early Hum Dev*. 2016;96:27–30

52. Garg B, Sharma D, Farahbakhsh N. Assessment of sickness severity of illness in neonates: review of various neonatal illness scoring systems. *J Matern Fetal Neonatal Med*. 2018; 31(10):1373–1380

53. Ramanathan K, Antognini D, Combes A, et al. Planning and provision of ECMO services for severe ARDS during the COVID-19 pandemic and other outbreaks of emerging infectious diseases. *Lancet Respir Med*. 2020;8(5): 518–526

54. Stylianos S. Guidelines for ECMO cannulation and candidacy for COVID-19+/PUI pediatric and neonatal patients. 2020.Available at: https://www.pedsurglibrary.com/apsa/ub?cmd=repview&type=682-50&name=13_1884034_PDF. Accessed April 23, 2020

55. Pappalardo F, Montisci A. What is extracorporeal cardiopulmonary resuscitation? *J Thorac Dis*. 2017;9(6):1415–1419

56. Henry BM. COVID-19, ECMO, and lymphopenia: a word of caution. *Lancet Respir Med*. 2020;8(4):e24

57. MacLaren G, Fisher D, Brodie D. Preparing for the most critically ill patients with COVID-19: the potential role of extracorporeal membrane oxygenation. *JAMA*. 2020;323(13):1245–1246

58. Curtis JR, Kross EK, Stapleton RD. The importance of addressing advance care planning and decisions about do-not-resuscitate orders during novel coronavirus 2019 (COVID-19). *JAMA*. 2020;323(18):1771–1772

59. Cha AE. Hospitals consider universal do-not-resuscitate orders for coronavirus patients. *The Washington Post*. March 25, 2020. Available at: https://www.washingtonpost.com/health/2020/03/25/coronavirus-patients-do-not-resucitate/. Accessed April 05, 2020

60. Bosslet GT, Pope TM, Rubenfeld GD, et al; American Thoracic Society ad hoc Committee on Futile and Potentially Inappropriate Treatment; American Thoracic Society; American Association for Critical Care Nurses; American College of Chest Physicians; European Society for Intensive Care Medicine; Society of Critical Care. An official ATS/AACN/ACCP/ESICM/SCCM policy statement: responding to requests for potentially inappropriate treatments in intensive care units. *Am J Respir Crit Care Med*. 2015;191(11):1318–1330

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