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Concepts: A Proposal for Selective Resuscitation of Adult Cardiac Arrest Patients in a Pandemic

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Abstract
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Abstract

Allocation of limited resources in pandemics begs for ethical guidance. The issue of ventilator allocation in pandemics has been reviewed by many medical ethicists, but as localities activate crisis standards of care and health care workers are infected from patient exposure, the decision to pursue cardiopulmonary resuscitation must also be examined to better balance the increased risks to healthcare personnel with the very low resuscitation rates of COVID-19 patients. A crisis standard of care that is equitable, transparent, and mindful of both human and physical resources will lessen the impact on society in this era of COVID-19. This paper builds upon previous work of ventilator allocation in pandemic crises to propose a literature-based, justice-informed ethical framework for selecting treatment options for cardiopulmonary resuscitation. The pandemic affects regions differently over time so these suggested guidelines may require adaptation to local practice variations.

Introduction

In 2020, the World Health Organization declared a pandemic of Coronavirus Disease 2019 (COVID-19), caused by the SARS-CoV-2 virus[1]. At the time of this writing, there have been 2,498,355 confirmed cases and 171,652 deaths worldwide, with 787,960 cases and 42,364 deaths occurring in the United States[2]. As the virus has spread throughout the world, health systems in numerous areas

(e.g., in Italy, Spain, Wuhan, and New York City) have been overwhelmed with crowded inpatient and critical care units and lack of respiratory support equipment, especially ventilators. Currently there is no vaccination or scientifically established pharmacologic treatment. COVID-19 causes a wide spectrum of illness, from asymptomatic infections and mild respiratory or gastrointestinal illnesses to pneumonia, acute respiratory distress syndrome, severe sepsis, myocarditis, congestive heart failure and cardiac arrest.

In addition to pulmonary complications of COVID-19, acute cardiovascular complications appear to be a significant sequelae of infection. In general, cardiovascular decompensation may be an end-stage manifestation of sepsis, primary respiratory failure or primary cardiac etiology. Proposed mechanisms for cardiac arrest related to COVID-19 include acute hypoxemic respiratory failure, myocarditis, malignant tachydysrhythmias, resulting in coronary plaque instability (i.e., Type 1 MI) secondary to inflammation[3], stress-induced cardiomyopathy or coagulopathy[4]. In the 2003 SARS-coronavirus epidemic, other suspected mechanisms of sudden death included acute decompensated heart failure from catecholamine excess and even from just physiologic stress related to defecation[5]. COVID-19 patients with myocardial injury have a much higher rate of mortality (51%) versus those without myocardial injury (4.5%)[6]. Emergency physicians rarely know the COVID-19 status of patients in the emergency department who experience cardiac arrest and each patient should be treated as a possible case.

Patients who decompensate to cardiac arrest and undergo cardiopulmonary resuscitation represent a very high-risk group for transmission of the SARS-CoV-2 virus to healthcare workers. Aerosolization of SARS-CoV-2, especially during intubation or chest compressions is an ongoing area of investigation and a focus of infection control guidance[7]. Infections in healthcare workers can impair the workforce of an emergency department and hospital, putting the community at greater risk of worse health outcomes. Infected healthcare workers can also unwittingly spread the infection to other patients, both during an asymptomatic prodrome and through viral shedding after recovery[4].

Emergency physicians are often tasked with resuscitating patients who suffer cardiac arrest and the COVID-19 pandemic may require modifying typical approaches to cardiopulmonary resuscitation. Even in environments with adequate resources prior to the pandemic, the mortality for out-of-hospital cardiac arrest in the US was high (~90%)[8] and still very high (70-80%) when the arrest

occurs in the hospital[9]. Cardiac arrest with COVID-19 patients is extremely lethal with a poor outcome in >99% of patients making the benefit-to-patient / risk-to-healthcare-team ratio even more stark[10]. Now, as emergency providers are facing the realities of this pandemic, tough choices may be forced especially when healthcare providers and resources are seriously constrained by the large numbers of patients in the pandemic. Because of the special risks to the healthcare facilities and individual providers by COVID-19, health care providers must be provided with evidence-based guidance in making decisions about attempted resuscitation of patients. Prolonged high-risk procedures such as cardiopulmonary resuscitation may result in transmission of the virus to poorly protected personnel, especially with critical shortages of HEPA filters for intubation and appropriate personal protective equipment (PPE).

Multiple states have recognized the need for civil liability relief for physicians in catastrophic health emergency proclamations leading to Crisis Standards of Care[11 12 13]. The American College of Emergency Physicians, through its Disaster Preparedness and Response Committee has defined 'crisis care 'as, "what a reasonable practitioner would do (and want for himself and his loved ones), given the limited resources at hand."[14] The interim guidance by the American Heart Association (AHA) has recommended that "health care systems consider policies to guide front-line providers in determining the appropriateness of starting and terminating CPR, taking into account COVID-19 status, comorbidities and severity of illness to estimate the likelihood of survival" [15]. This paper seeks to inform the practicing emergency physician of ethical considerations while offering a potential framework for selective cardiopulmonary resuscitation. This framework is based on patient-specific criteria for selective resuscitation with an adaptable treatment algorithm.

Policy and Ethical Considerations During the COVID-19 Pandemic

Multiple treatment changes that have been advocated in this pandemic are expert-opinion based and any guidelines thus far proposed have been and will continue to evolve. The sequential organ failure assessment (SOFA) score is part of proposed guidelines for ethical ventilator allocation during a public health emergency[16]. Multiple states have draft guidelines published online on resource allocation of ventilators but there is sparse data on the efficacy of these guidelines[1718 19]. One hospital in the UK found that it may have led to overtriage and withdrawal of ventilator support but the H1N1

influenza pandemic affected the young more heavily than the current COVID-19 pandemic[20]. The ventilator allocation guidelines have the benefit of a committee that can review the data, age, and course of the patient to decide whether to continue therapy or withdraw and reallocate the ventilator. In the resuscitation bay, clinical-based risk-stratification metrics can provide a starting base for which resuscitations of the adult patient are the most likely to succeed. Practicing emergency physicians do not have the luxury of time or a committee at bedside during cardiopulmonary resuscitation and must be able to make a rapid bedside decision that weighs the odds of benefit to the patient with the risks to their team and health system.

The medical ethical decision-making process involves the concepts of non-maleficence, beneficence, patient autonomy along with hope and distributive justice[21]. The emergency physician must consider 5 specific components: Duty to care, duty to steward resources (which takes into account the need for a ventilator and potential exposure to the health care providers), duty to plan (multiple states have planning algorithms for ventilator allocation), distributive justice (avoiding socioeconomic considerations) and transparency (providing this approach to all involved). Other ethical considerations described have included accountability, proportionality, solidarity, reciprocity, utility, fairness, consistency and veracity[22]. The following sections of the paper discuss existing and proposed policy guidelines with careful exploration of the challenging ethical questions facing emergency providers.

Proposed Criteria for Attempting Resuscitation

Any guidelines for limiting patient treatment to a potentially life-saving intervention require significant scrutiny and should only be used in dire circumstances. Physicians must exercise their best clinical judgment in how to proceed with each individual patient as their COVID-19 status may be unknown. These guidelines are not ideal for pre-hospital patients as their COVID-status is usually unknown and hospital labs help inform the decision-making criteria. Our proposed guidelines may be described as a justice-informed utilitarian framework that provides the greatest good to the largest number of potentially healthy years while also giving everyone at least a chance.

For a practicing clinician, the decision to cease cardiopulmonary resuscitation efforts is difficult to make and can create even more distress when prolonging largely futile efforts may further expose the medical team to SARS-CoV viral particles despite adequate PPE[23]. Informed guidance is

often sought although not frequently available especially in novel situations. Deciding on resuscitation length based on age alone may not be fair or ethical as elderly patients may be more fit or functionally independent than younger patients with comorbidities. Subjective evaluations of a patient's quality of life are fraught with potential for discrimination especially against the chronically disabled. Discuss the critical nature of the patient with the power-of-attorney as they may agree to palliative care for the patient thus resolving much anxiety about initiating cardiopulmonary resuscitation (CPR). Penn Medicine legal scholars have recently recommended, in the present crisis that[24]:

1. Attending physicians are not obligated to offer or to provide CPR if resuscitative treatment would be medically inappropriate, even at the request of a patient or legally authorized representative (LAR).
2. If the attending physician determines that CPR is not medically appropriate, they should solicit the independent review of a second attending physician not involved in the patient's care
3. Physicians who decide not to offer CPR should inform the patient or LAR of this decision and rationale and assure the patient that all other forms of indicated care will continue. Assent should be sought but is not required.

The ethical allocation of scarce medical resources may be directed to workers who perform 'essential social functions', as is the case in Michigan but may not be true in all states[17]. These 'essential 'workers specifically for this pandemic include emergency physicians, hospitalists, intensivists, mental health professionals and nurses, first responders and public health scientists[25]. Police, fire and military, or energy grid and telecommunication personnel are also deemed critical for the ongoing functioning of society. Prioritizing the resuscitation of 'essential 'workers may be useful in a long pandemic where the recovery period is shorter than the pandemic length but the definition of 'essential 'varies between states and segments of society and will need further discussion that is beyond the scope of this paper.

Unacceptable criteria for resuscitation attempts

Michigan has helped define criteria that are unacceptable to consider when allocating ventilators to patients[17]. Similarly, health care personnel should not utilize these characteristics in deciding who to

attempt cardiac arrest resuscitation on due to their inherent lack of fairness and potential for abuse or discrimination.

1. Social characteristics including ethnicity, gender, national origin, sexual orientation, religious affiliation and disabilities unrelated to immediate medical prognosis.
2. Social worth including 'non-essential 'personnel including job status, training or education-level, social standing, personal or familial relationships, belief systems, political affiliations, ability to pay currently or in the future.

The option of lottery for ventilator allocation within subgroups of populations such as age or comorbidities does *not* directly apply to resuscitation in an emergency department. Upon admission after resuscitation, critical and palliative care teams can apply definable metrics that can help provide estimations of prognosis and help with inpatient risk stratification. Unfortunately, this option is unavailable in most emergency departments in a reasonable timeframe.

Anticipating the decompensation of patients in the COVID-19 era

The Ontario Health Plan for an Influenza Pandemic (OHPIP) first described in 2006 a critical care triage tool based in part on the Sequential Organ Failure Assessment (SOFA) score, which takes into account clinical measures of functioning in key organs and systems: pulmonary, hepatic, neurologic, renal, hematologic and cardiac output[26]. A perfect SOFA score (0) indicates normal function in all six categories. As the score increases due to dysfunction, the risk of acute mortality also increases, with the worst possible score of 24 representing significant impairment in all six systems. If the physician must respond to a sudden arrest in the emergency department, enlist a colleague to calculate the SOFA score based on the electronic medical record (EMR) to help with risk-stratification and inform the need to provide more than a few minutes of resuscitation. Currently in development are criteria for predicting decompensation in the ED, although COVID-19 patients were not included in the study population[27].

The largest limitation of the SOFA score is the need to have the lab results available to calculate the score. Using the EMR to find the most recent lab results may help expedite the decision although labs from the acute presentation is ideal. Other prognostic scores considered include the systemic inflammatory response syndrome (SIRS), quick SOFA (qSOFA), modified SOFA (mSOFA),

and Acute Physiology And Chronic Health Evaluation (APACHE II). SIRS and qSOFA, while much quicker to calculate, suffers from worse prognostic accuracy compared to SOFA[28]. mSOFA is simpler than SOFA but still requires blood testing. APACHE II can help determine the admission mortality risk as well but requires lab work, includes age as a factor and has not been as well-cited by crisis-guidance literature[29]. The CRASS formula has been helpful in predicting hospital discharge of patients who have suffered an out-of-hospital cardiac arrest and awaits further adoption and comparison to the more studied SOFA score as the pandemic progresses[30]. In the emergency department, patients often decompensate before the laboratory results needed for the SOFA score and in these cases, a second, non-treating physician consultation is advised.

Step 1 - Highly Lethal Risk Factors

Cardiopulmonary resuscitation may be considered medically inappropriate, especially in conditions of crisis standards of care, in patients with very high probability of death. New York State has defined a list of criteria loosely based on the exclusion criteria from OHPIP 2008's clinical ventilator allocation protocol and a concept paper from Hick and O'Laughlin[31].

If the patient has a condition on the highly lethal risk factor list and is acutely declining, involve an independent review by a second clinician or palliative consult to consider comfort care [25]. These are patients with the highest probability of immediate or near-immediate death even with cardiopulmonary resuscitation and mechanical ventilation. In crisis-level constraints, the risks of infection of the health care team greatly outweighs the small benefit to a patient who has highly lethal risk factors and so the physician may consider a limited resuscitation effort, if any. Additionally, patients who have had an unwitnessed, asystolic arrest rarely survive to hospital discharge[32] and have been recommended by others to not have in-hospital cardiopulmonary resuscitation initiated if the hospital is in a pandemic crisis [33].

Highly Lethal Risk Factors for Adult Patients

Immediate or Near-Immediate Mortality Despite Aggressive Therapy

(adapted from NYS DOH Draft Statement[19])

Cardiac arrest: unwitnessed arrest in asystole, recurrent arrest unresponsive to standard ACLS; trauma-related arrest

Persistent SBP <90 despite adequate fluid resuscitation and vasopressor therapy

Traumatic brain injury with no motor response to pain (best motor response = 1) (See Appendix 1)

Severe burns: where predicted survival ≤ 10% even with aggressive therapy (See Appendix 1)

Any other conditions resulting in immediate or near-immediate mortality even with aggressive therapy (e.g. subarachnoid hemorrhage with herniation, exsanguination, terminal cancer)

Step 2 - Mortality Risk Assessment. See Table 1

Among patients who do not meet the above criteria, the initial SOFA score (Table 1) may be used to predict likelihood of mortality for patients requiring ventilatory support[34]. Ideally, calculation of their SOFA score will occur before clinical deterioration. Clinicians should discuss and consider recommending do-not-resuscitate status to patients with a SOFA score >11 (80% mortality) or if recent labs are unavailable. A non-treating clinician can access the EMR-based data and calculate a SOFA score. Patients with pre-arrest SOFA scores between 8 and 11 have a reasonable chance of survival on the ventilator (<50% mortality) and may benefit from the standard ACLS algorithm performed by health care providers in appropriate PPE[35]. Patients with a SOFA score >11 calculated based on lab data within the past 90 days are the least likely to survive intubation following cardiac arrest. Blanket do-not-resuscitate (DNR) orders for patients with cardiac arrest during the COVID-19 pandemic have been discussed but this would be extremely unfortunate for those who may not even have had COVID-19 testing when they arrive in the emergency department[36].

We propose an adaptable decision matrix (Figure 1) that can be applied to cardiac arrest patients during the COVID-19 pandemic based on the criteria above. For patients who have unwitnessed, asystolic events, it has been recommended to cease efforts and initiate comfort care measures after just 6-10 minutes of CPR if initiated. 10-15 minutes may be considered for those with a calculated SOFA score of 8-11. This provides time to address immediately reversible life threats. As fewer resources are available (e.g. lack of HEPA filters or negative pressure rooms) even the time to

provide resuscitation for patients in this category may constitute a significant risk to the health care team. A suggested maximum of 30 minutes may be considered for those with SOFA <8 as they are more likely to recover with less organ dysfunction. Physicians will always have clinical discretion to continue beyond 30 minutes. Consider a second opinion with a licensed physician to help with determination of futility of medical care especially when labs are not available to assist with SOFA score calculation.

Ventilator allocation schemes have considered appeals by the disabled or family members who feel the withdrawal of care would be unjust to their family members[37]. The appeals process would focus on looking for technical errors to determine if reconsideration of withdrawal of ventilatory support could proceed. With minutes to decide, and family not at the bedside in the suspected COVID-19 patient, a 2-physician mechanism is proposed with one physician not directly involved in the care of the patient to act as an advocate[20,38]. This scheme would work in departments where there are two attending emergency physicians; in small facilities, a single attending may need to reach out to a hospitalist or other specialist.

Resource-Tiered Approach to CPR for Candidate Patients

Much will be written about the response to COVID-19 in the emergency department in the coming weeks. Each hospital system will have different levels of resources that may change as the pandemic evolves and supply lines adapt. Below is a description of potential options available for ED management of patients who suffer cardiac arrest. With the variety of presentations of the pandemic, it may be difficult to differentiate between patients with suspected COVID-19 and those not suspected of a COVID-19 infection[39]. Available resuscitation options will also evolve over time as health care providers who return to work after becoming infected with or vaccinated for COVID-19 are re-introduced to the health care system. These providers can be useful in forming the responding team although asymptomatic carriage and potential transmission via fomites of COVID-19 may require continued use of PPE to minimize inadvertent passage to non-immune health care personnel.

Ideal option: Consider airborne PPE-protected teams 24/7, immediately available for cardiac arrests throughout the hospital and positioned closely to patients who have a high risk of decompensating

based on monitored clinical data such as eCART, MEWS or NEWS for inpatients[40] or pre-admission MuLBSTA[41] for viral pneumonia (PSI / CURB-65 scores are appropriate for bacterial pneumonia). There are no prognostic scores yet developed for COVID-19 pneumonia[42]. Placing defibrillation pads on the electrically unstable patient prepares for timely defibrillations and minimizes the need to perform chest compressions. Mechanical compression devices can help minimize the number of responders needed.

Interim recommendations: The AHA's interim guidance recognizes the limited availability of mechanical compression devices but emphasizes provider protection with techniques to reduce aerosolization risk[15]. Their recommendations include limiting personnel and donning PPE before any compressions but moving quickly to endotracheal intubation. Ventilate with bag-mask only in a negative pressure room with a HEPA filter and tight seal with a securable BIPAP mask. Intubate only under first-pass maximal success settings or use a supraglottic airway with HEPA filter attached until the patient has return-of-spontaneous-circulation. Sterilizable intubation boxes may help reduce aerosolization risk; additional aerosol mitigation strategies and the further AHA guidance on out-of-hospital and in-hospital cardiac arrests are beyond the scope of this paper.

Crisis Option: If appropriate PPE is unavailable, ask for *informed* clinical volunteers to assist in the resuscitation with any available personal protective equipment. Inform the volunteers of the risk-stratification specific to the patient prior to any resuscitation attempt. This is extremely important in cases where there is the lack of facemasks as compression-only CPR (CO-CPR) may be considered an aerosol generating procedure[43 44]. Defibrillation is likely safe[43]. In the most recent severe acute respiratory syndrome outbreak, surveyed family members who had just been taught compression-only CPR (CO-CPR) were just as willing to perform CO-CPR; whereas, unrelated bystanders were significantly less willing in a pandemic[45]. These options may be adapted by dispatcher-assisted cardiac arrest responses.

Post-Resuscitation Care

If resuscitation has been successful but no ventilators remain, contact the closest available hospital, expedite transport and utilize the EMS system's ventilator equipment while having respiratory

therapy provide bag-valve-HEPA-filter ventilations. This method will occupy the respiratory therapist until EMS can arrive. Consider having PPE-protected EMS personnel assist the respiratory therapist / nurse with the transport ventilator. If there are no ventilators available within reasonable transport distance and no chance of ventilators opening up, the last option would be to terminate mechanical ventilation when necessary and initiate palliative care in order to free staff to care for patients with improved chance of survival. Few institutions have the ability to provide ECMO for patients with ARDS and these guidelines may not apply in these cases.

Legal Concerns

These guidelines will need to be applied consistently across each individual state, region and health system and reviewed continuously with periodic reassessments. Each state will have their own legal considerations but with declarations of disaster, suspensions of state statutes, local laws and ordinances can occur. Many states have protections from liability in a public health emergency such as an influenza pandemic and, although not yet tested, should apply to this COVID-19 pandemic. Good Samaritan laws do not apply in a facility that has proper and necessary medical equipment[46]. With lack of sufficient PPE and ventilators, this law may be tested and unfortunately there are incomplete protections for delays in care currently with existing laws. As the pandemic evolves, the executive branches of government may implement selective waivers to HIPAA and EMTALA. At the time of this writing, New York, Michigan and 9 other states have issued executive orders protecting physicians from civil liabilities related to COVID-19 management[47].

Withdrawal of Life-Sustaining Therapy

Palliative care resources including spiritual care as defined by the family, will need to be made available when requested by the family or the clinical team. Consult the hospital system's palliative care team, possibly through telemed, to interface with the power-of-attorney before decompensation or intubation to minimize risk of civil litigation[48]. It is currently unknown whether patients who die from COVID-19 may be able to provide organ donation[49 50]. Bedside viewing of the deceased may be not safe due to persistent fomites[51].

References

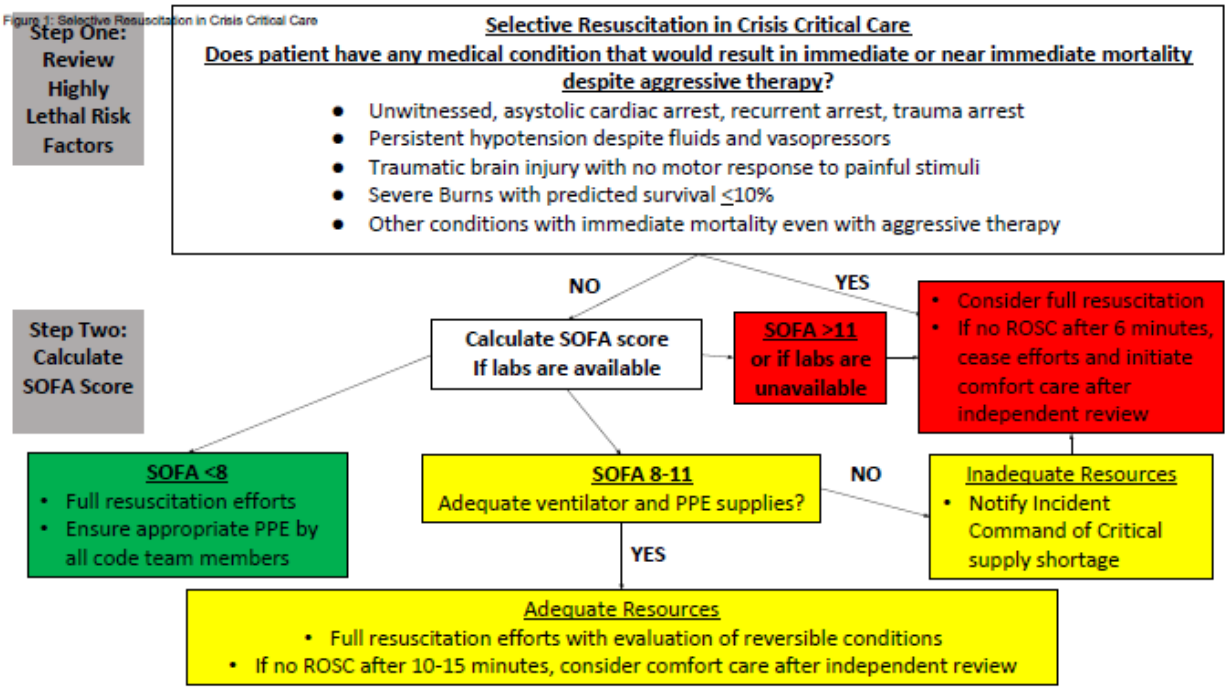

Table 1: Sequential Organ Failure Assessment (SOFA) Score Scale (with permission by Springer Nature)

Variable	0	1	2	3	4	Score (0-4)
PaO_2/FiO_2 mmHg	> 400	< 400	< 300	< 200	< 100	
Platelets, x 10^3 /µL	> 150	< 150	< 100	< 50	< 20	
Bilirubin, mg/dL	< 1.2	1.2 - 1.9	2.0 - 5.9	6.0 - 11.9	> 12	
Hypotension	None	Mean ABP < 70 mmHg	Dop < 5	Dop 6 - 15 or Epi < 0.1 or Norepi < 0.1	Dop > 15 or Epi > 0.1 or Norepi > 0.1	
Glasgow Coma Score	15	13 - 14	10 - 12	6 - 9	< 6	
Creatinine, mg/dL	< 1.2	1.2 - 1.9	2.0 - 3.4	3.5 - 4.9	> 5	
					Total (0-24):	

Dopamine [Dop], epinephrine [Epi], and norepinephrine [Norepi] doses in µgram/kg/min (administered for at least one hour)

[1] WHO Director-General's opening remarks at the media briefing on COVID-19 - 11 March 2020. World Health Organization. www.who.int/dg/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020. Accessed April 17, 2020.
[2] Coronavirus COVID-19 Global Cases by the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University. Johns Hopkins University. coronavirus.jhu.edu/map.html Accessed April 17, 2020.
[3] Sutherland M. COVID-19 Complications. Critical Care Project. http://covid19.ccproject.com Accessed April 17, 2020
[4] 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. Lancet. 2020 Mar 11. PMID: 32171076
[5] Pan SF, Zhang HY, Li CS, Wang C. Cardiac arrest in severe acute respiratory syndrome: analysis of 15 cases. Zhonghua Jie He He Hu Xi Za Zhi. 2003 Oct;26(10):602-5. PMID: 14633442
[6] Shi S, Qin M, Shen B, et al. Association of cardiac injury with mortality in hospitalized patients with COVID-19 in Wuhan, China. JAMA Cardiol. 2020, Mar 25. Epub. PMID: 32211816
[7] Interim Infection Prevention and Control Recommendations for Patients with Suspected or Confirmed Coronavirus Disease 2019 (COVID-19) in Healthcare Settings. Centers for Disease Control. https://www.cdc.gov/coronavirus/2019-ncov/infection-control/control-recommendations.html Accessed April 17, 2020.
[8] Benjamin EJ, et al. Heart Disease and Stroke Statistics—2018 Update: A Report from the American Heart Association. Circulation. 2018;137:e67–e492. PMID 29386200
[9] Anderson LW, Holmberg MY, Berg KM, Donnino MW, Granfeldt A. In-Hospital Cardiac Arrest: A Review. JAMA. 2019 Mar; 321(12): 1200-1210. ncbi.nlm.nih.gov/pmc/articles/PMC6482460
[10] Shao F, Xu S, Ma X, et al. In-hospital cardiac arrest outcomes among patients with COVID-19 pneumonia in Wuhan, China. Resuscitation. 2020 Apr 10. PMID 32283117
[11] Hick, J. L., D. Hanfling, M. K. Wynia, and A. T. Pavia. 2020. Duty to Plan: Health Care, Crisis Standards of Care, and Novel Coronavirus SARS-CoV-2. NAM Perspectives. Discussion paper. National Academy of Medicine. Washington, DC. https://doi.org/10.31478/202003b Accessed April 17, 2020.
[12] EXECUTIVE ORDER No. 2020-30 Temporary relief from certain restrictions and requirements governing the provision of medical services. https://www.michigan.gov/whitmer/0,9309,7-387-90499_90705-523481--,00.html. Accessed April 17, 2020.
[13] Maryland Public Safety Section 14-3A-06. https://law.justia.com/codes/maryland/2005/gps/14-3A-06.html. Accessed April 17, 2020.
[14] Guidelines for Crisis Standards of Care during Disasters, 2013, June. https://www.acep.org/globalassets/uploads/uploaded-files/acep/clinical-and-practice-management/policy-statements/information-papers/guidelines-for-crisis-standards-of-care-during-disasters.pdf Accessed April 17, 2020
[15] Edelson DP, Sasson C; Chan PS, et al. Interim Guidance for Basic and Advanced Life Support in Adults, Children, and Neonates With Suspected or Confirmed COVID-19. Circulation. 2020 Apr 9; Epub. PMID 32270695
[16] Powell T, Christ KC, Birkhead GS. Allocation of ventilators in a public health disaster. Disaster Med Public Health Prep. 2008 Mar;2(1):20-6. PMID 18388654
[17] Romney D, Fox H, Carlson S, et al. Allocation of Scarce Resources in a Pandemic: A Systematic Review of U.S. State Crisis Standards of Care Documents. Disaster Med Public Health Prep. 2020 Apr 16:1-19. Epub. PMID: 32295662
[18] Ventilator Allocation Guidelines. New York State Task Force on Life and the Law. New York State Department of Health. November 2015. https://www.health.ny.gov/regulations/task_force/reports_publications/docs/ventilator_guidelines.pdf. Accessed April 17, 2020.

[19] Oregon Crisis Care Guidance: Providing a Framework for Crisis Healthcare. https://www.theoma.org/OMA/Learn-content/Public-Health-Library/Crisis-Care.aspx. Accessed April 17, 2020.
[20] Khan Z, Hulme J, Sherwood N. An assessment of the validity of SOFA score based triage in H1N1 critically ill patients during an influenza pandemic. Anaesthesia. 2009 Dec;64(12):1283-8. PMID: 19860754
[21] The Belmont Report: Ethical Principles and Guidelines for the Protection of Human Subjects of Research, Report of the National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research. Federal Register **44** (76): 23191–7. https://www.hhs.gov/ohrp/regulations-and-policy/belmont-report/read-the-belmont-report/index.html Accessed April 17, 2020.
[22] Guidelines for Ethical Allocation of Scarce Medical Resources and Services During Public Health Emergencies in Michigan. Version 2.0. www.mimedicalethics.org/Documentation/Michigan%20DCH%20Ethical%20Scarce%20Resources%20Guidelines%20v2%20rev%20Nov%202012.0.pdf. Accessed April 17, 2020.
[23] Hwang SY, Yoon H, Yoon A, et al. N95 filtering facepiece respirators do not reliably afford respiratory protection during chest compression: A simulation study.Am H Emerg Med. 2020 Jan; 38(1):12-17. PMID: 30955924
[24] Guidance for Decisions Regarding Cardiopulmonary Resuscitation during the COVID-19 Pandemic. https://adobe.ly/3bujCW9. Accessed April 17, 2020.
[25] Farmer JC, Wax R, Baldisseri MR. Preparing your ICU for Disaster Response. Chapter 8: Ethical Decision Making in Disasters: Key Ethical Principles and the Role of the Ethics Committee. Society of Critical Care Medicine; 2012. https://sccm.org/getattachment/Disaster/PreparingforDisasterResponse.pdf. Accessed April 17, 2020.
[26] Vincent JL, Moreno R, Takala J, et al. The SOFA (Sepsis-related Organ Failure Assessment) score to describe organ dysfunction/failure. Intensive Care Med. 1996 Jul;22(7):707-710. PMID 8844239
[27] Mitchell, OJL, Edelson, DP, Abella, BS. Predicting cardiac arrest in the emergency department. *JACEP Open*. 2020; 1- 6. https://doi.org/10.1002/emp2.12015
[28] Raith EP, Udy AA, Bailey M, McGloughlin S, MacIsaac C, Bellomo R, Pilcher DV; Australian and New Zealand Intensive Care Society (ANZICS) Centre for Outcomes and Resource Evaluation (CORE). Prognostic Accuracy of the SOFA Score, SIRS Criteria, and qSOFA Score for In-Hospital Mortality Among Adults With Suspected Infection Admitted to the Intensive Care Unit. JAMA. 2017 Jan 17;317(3):290-300. doi:10.1001/jama.2016.20328.
[29] Knaus WA, Draper EA, Wagner DP, Zimmerman JE. APACHE II: a severity of disease classification system. Crit Care Med. 1985 Oct;13(10):818-29. PMID: 3928249
[30] CaRdiac Arrest Survival Score (CRASS) - A tool to predict good neurological outcome after out-of-hospital cardiac arrest. Seewald S, Wnent J, Lefering R. et al. Resuscitation. 2020 Jan 1; 146:66-73 PMID.31730900
[31] Hick JL, O'Laughlin DT. Concept of Operations for Triage of Mechanical Ventilation in an Epidemic. Academic Emergency Medicine 2006 Feb;13(2):223-9. PMID 16400088
[32] Sasson C, Rogers MA, Dahl J, Kellermann AL. Predictors of survival from out-of-hospital cardiac arrest: a systematic review and meta-analysis. Circ Cardiovasc Qual Outcomes. 2010 Jan;3(1):63-81. PMID: 20123673
[33] Väyrynen T, Kuisma M, Määttä T, Boyd J. Medical futility in asystolic out-of-hospital cardiac arrest. Acta Anaesthesiol Scand. 2008 Jan;52(1):81-7. PMID: 17996007
[34] Vincent JL, Moreno R, Takala J, Willatts S, De Mendonça A, Bruining H, Reinhart CK, Suter PM, Thijs LG. The SOFA (Sepsis-related Organ Failure Assessment) score to describe organ dysfunction/failure. On behalf of the Working Group on Sepsis-Related Problems of the European Society of Intensive Care Medicine. Intensive Care Med. 1996 Jul;22(7):707-10. PMID: 8844239
[35] Ferreira FL, Bota DP, Bross A, Mélot C, Vincent JL. Serial evaluation of the SOFA score to predict outcome in critically ill patients. JAMA. 2001 Oct 10;286(14):1754-8. PMID: 11594901

[36] 'We're going to be coding dead people': Hospitals consider do-not-resuscitate order for all COVID-19 patients https://www.beckershospitalreview.com/public-health/we-re-going-to-be-coding-dead-people-hospitals-consider-do-not-resuscitate-order-for-all-covid-19-patients.html Accessed April 17, 2020.
[37] Complaint of Disability Rights Washington, Self Advocates in Leadership, The Arc of the United States, and Ivanova Smith Against the Washington State Department of Health (WA DOH), the Northwest Healthcare Response Network (NHRN) and the University of Washington Medical Center (UWMC) https://www.centerforpublicrep.org/wp-content/uploads/2020/03/OCR-Complaint_3-23-20-final.pdf Accessed April 17, 2020.
[38] ACEP Guidelines for Crisis Standards of Care during Disasters. https://www.acep.org/globalassets/uploads/uploaded-files/acep/clinical-and-practice-management/policy-statements/information-papers/guidelines-for-crisis-standards-of-care-during-disasters.pdf Accessed March 24, 2020.
[39] Emanuel EJ, Persad G, Upshad R, et al. Fair Allocation of Scarce Medical Resources in the Time of Covid-19. N Engl J Med. 2020 Mar 23. PMID 32202722
[40] Green M, Lander H, Snyder A, Hudson P, Churpek M, Edelson D. Comparison of the Between the Flags calling criteria to the MEWS, NEWS and the electronic Cardiac Arrest Risk Triage (eCART) score for the identification of deteriorating ward patients. Resuscitation. 2018 Feb;123:86-91. PMID 29169912
[41] Guo L, Wei D, Zhang X, Wu Y, Li Q, Zhou M, Qu J. Clinical Features Predicting Mortality Risk in Patients With Viral Pneumonia: The MuLBSTA Score. Front Microbiol. 2019 Dec 3;10:2752. PMID 31849894
[42] Chen JH, Chang SS, Liu JJ, Chan RC, Wu JY, Wang WC, Lee SH, Lee CC. Comparison of clinical characteristics and performance of pneumonia severity score and CURB-65 among younger adults, elderly and very old subjects. Thorax. 2010 Nov;65(11):971-7. PMID 20965934
[43] COVID-19 Practical Guidance for Implementation. www.ilcor.org/covid-19 Accessed April 20, 2020.
[44] Tran K, Cimon K, Severn M, Pessoa-Silva CL, Conly J. Aerosol Generating Procedures and Risk of Transmission of Acute Respiratory Infections to Healthcare Workers: A Systematic Review. PLoS One. 2012; 7(4): e35797. PMID: 22563403
[45] Lam KK, Lau FL, Chan WK, Wong WN. Effect of severe acute respiratory syndrome on bystander willingness to perform cardiopulmonary resuscitation (CPR)--is compression-only preferred to standard CPR. Prehosp Disaster Med. 2007 Jul-Aug;22(4):325-9. PMID: 18019100
[46] Clark PA. Medical Futility: Legal and Ethical Analysis. *Virtual Mentor.* 2007;9(5):375-383. PMID 23217998
[47] Executive Order. Continuing Temporary Suspension and Modification of Laws Relating to the Disaster Emergency. www.governor.ny.gov/sites/governor.ny.gov/files/atoms/files/EO_202.10.pdf. Accessed April 17, 2020.
[48] Cohen IG, Crespo AM, White DB. Potential Legal Liability for Withdrawing or Withholding Ventilators During COVID-19: Assessing the Risks and Identifying Needed Reforms. *JAMA.* 2020 April 01. Epub. PMID 32236491
[49] Pan L, Zeng J, Yang H. Challenges and countermeasures for organ donation during the SARS-CoV-2 epidemic: the experience of Sichuan Provincial People's Hospital. Intensive Care Med. 2020 Feb 25. PMID: 32100062
[50] Gift of Life Marrow Registry COVID-19 Statement. https://www.giftoflife.org/posts/post/Gift-of-Life-Marrow-Registry-COVID-19-Statement. Accessed April 17, 2020.
[51] Santarpia JL, Rivera DN, Herrera V, et al. Transmission Potential of SARS-CoV-2 in Viral Shedding Observed at the University of Nebraska Medical Center. Preprint. March 26, 2020. doi: https://doi.org/10.1101/2020.03.23.20039446