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The Importance of Incorporating Patient Throughput in Crisis Standards of Care Simulations

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Research Letter

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Numerous publications have sought to further our understanding of how crisis standards of care (CSOC) strategies might perform, with specific attention to excessive deaths or exacerbating existing social disparities, during the coronavirus disease (COVID-19) pandemic. We write to raise an important concern with many CSOC studies to date, that simulate patient cohorts by synchronizing patients' presentation to *a single time point*, rather than the reality where patients present continually over time.[1–4] This collapsed model may not accurately reflect patient throughput and dynamic resource strain, which would preclude identifying those patients affected by CSOC policies. Understanding how CSOC might perform remains important as areas within New Hampshire, Arizona, New Mexico, Idaho, Alaska, and Maryland have activated their own crisis standards of care protocols.

Methods

All intubated COVID-19 patients at a single New York City (NY) health care system during the first surge (March 1, 2020 to June 30, 2020) were included in a simulation requiring CSOC activation once 95% of pre-pandemic ventilators were utilized and lasted 2 weeks (crisis period), consistent with a prior simulated length of ventilator rationing utilizing patient throughput under the New York State Ventilator Allocation Guidelines (NY[5]) CSOC.[6] Patient charts were reviewed to determine whether NY, Maryland (MD),[7] Pittsburgh (PA),[8] Saskatchewan Canada (SAC),[9] and California (CA)[10] CSOC criteria were satisfied (Table 1, Supplemental Methods) and whether patient ventilator usage occurred during the 2-week crisis period. NY, MD, SAC, and CA** CSOC use exclusionary criteria to preclude patients from receiving a ventilator under CSOC. Subsequently, NY and SAC only use a Sequential Organ Failure Assessment (SOFA) score for triage, whereas MD, PA, and CA all integrate graded comorbidities, in addition to a SOFA score to generate an overall triage score for ventilator allocation. PA, CA, and SAC each make occupational accommodations to partially prioritize whether the patient is an essential, critical, or occupation related to health care, respectively. PA uses the Area Deprivation Index (ADI, State scores 8-10) to favorably adjust an overall priority score for a ventilator, whereas other CSOC use the Social Vulnerability Index (SVI, scores ≥ 0.75); both were derived from the patient's address. Categorical data were analyzed with the chi-squared test (95% confidence interval). This study was exempt by the New York University Langone Institutional Review Board.

Results

In total, 911 patients were included in the cohort, of which 573 were involved during the crisis period. Table 2 depicts the total affected, excluded, comorbidities modifying triage score, and the occupation or social vulnerability adjustment by each CSOC. NY, MD, PA, SAC, and CA would have excluded 1, 3, 0, 93, and 3 patients, respectively, for the entire cohort, except 0, 0, 0, 45, and 2, respectively, during the specific crisis period. MD, PA, and CA would have modified 44, 88, and 106 individuals' triage scores, respectively, due to comorbidities in the entire cohort but only 17, 46, and 43, respectively, during the specific crisis period. The crisis period statistically affected MD ($P = 0.04$) and CA ($P = 0.0056$), with a trend seen for PA and SAC CSOC.

Discussion

When studying how resource allocation under CSOC might perform, any simulation that synchronizes all admissions rather than incorporating real patient throughput and dynamic resource strain would inadvertently include patients whose outcomes would be associated with normal or contingency standards of care instead of those truly secondary to CSOC. This failure to identify which patients would actually be affected by CSOC guidelines would likely distort valuable CSOC objectives, such as maximizing life-years saved without exacerbating existing

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Table 1. Crisis standards of care exclusion and triage score modifiers grouped by theme

				New York (NY)[5]	Maryland (MD)[7]	Pittsburgh * (PA)[8]	Saskatchewan (Canada, SAC)[9]	California ** (CA)[10]
Exclusion criteria	Admission diagnosis		Cardiac arrest	Yes	Yes	–	Yes	Yes
			Trauma	Yes	–	–	Yes	Yes
			Burns	Yes	Yes	–	Yes	Yes
			Stroke	–	–	–	Yes	Yes
	Comorbidities		Heart disease	–	–	–	Yes	–
			Lung disease	–	–	–	Yes	–
			Liver disease	–	–	–	Yes	–
			Neuro disease	–	Yes	–	Yes	Yes
			Malignancy	–	–	–	Yes	–
			Aged and frail	–	–	–	Yes	–
Triage prioritization score	SOFA score			Yes DYNAMIC	Yes DYNAMIC	Yes STATIC	Yes STATIC	Yes STATIC
	Fixed triage score modifiers	Comorbidities	Trauma	–	Yes	–	–	–
			Heart disease	–	Yes	Yes	–	Yes
			Lung disease	–	Yes	Yes	–	Yes
			Liver disease	–	Yes	Yes	–	Yes
			Kidney disease	–	–	Yes	–	Yes
			Neuro disease	–	Yes	Yes	–	Yes and frail
			Malignancy	–	Yes	Yes	–	Yes
		Special patient populations	Pregnancy	–	Yes	–	Yes	Yes
			Occupation	–	–	Essential	Health care	Critical
			Social vulnerability	–	–	Yes	–	–
			Transplant	–	–	–	Yes	Yes
			Complex Post-operative	–	–	–	–	Yes

See Supplemental Methods for specific criteria and how operationalized. Sequential Organ Failure Assessment (SOFA) score. Fixed triage score modifiers can deprioritize (comorbidities) or increase the prioritization (special patient populations) of an individual for a scarce resource.
*As expressed in the original CSOC publication.
**California CSOC does not have an explicit exclusion category but provides to only this group if excess supply is present.

Table 2. Prevalence of patients satisfying exclusion or triage score modifying criteria for 5 Crisis Standards of Care strategies during the crisis period vs entire cohort

	Entire Cohort	Crisis Period	P value
Total Number of Patients	911	573	
New York (NY)			
Excluded	1	0	
Maryland (total affected, MD)	47	17	**0.043**
Excluded	3	0	
Triage Modified	44	17	**0.078**
Pittsburgh (PA)			
Triage Modified	88	46	0.29
Essential Occupation	66	37	0.94
Social Vulnerability (ADI)	19	10	0.65
Social Vulnerability (SVI)	348	212	0.64
Saskatchewan (Canada, SAC) Excluded	93	45	0.13
Healthcare Occupation	26	18	0.45
California (total affected, CA)	109	43	**0.0056**
Excluded	3	2	
Triage Modified	106	46	**0.026**
Critical Occupation	33	21	0.28
Immediate post-operative care of complex surgical patients	8	3	
Patients receiving solid organ transplants	3	1	
Pregnancy (MD, SAC, CA)	5	5	

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social disparities. While MD and CA were the only CSOC strategies reaching statistical significance for cohort differences when including patient throughput, we believe the PA and SAC trends toward significance represent a limitation of our cohort size. We remain concerned with CSOC features, as expressed in NY, MD, and SAC CSOC, that categorically exclude patients regardless of resource strain because rationing might not occur dichotomously but across a continuum over time. While PA has replaced a list of objective comorbidity criteria with a physician's broad assessment of expected death within 5 years or 1 year, despite successful treatment of acute illness, objective criteria achieve impartiality, preserve fairness toward patients, promote transparency with the community, maintain reproducibility between providers, eliminate the encroachment of bias or prejudices by decision makers, and may reduce provider distress about resource allocation decisions.

A limitation was that this study was not a full simulation designed to determine excessive deaths per CSOC; however, our objective was rather to demonstrate the differences in cohort compositions that would likely affect key CSOC outcomes. A 2-week crisis period was determined by the length of time ventilators required to be rationed during a separate NY-CSOC simulation in this patient cohort.[6] Other CSOCs might require a shorter or longer duration of rationing that would affect those patients included in a crisis period cohort. In conclusion, we highlight the dynamic nature of the crisis period and encourage future CSOC studies to incorporate dynamic patient throughput to correctly capture patients who would be affected by CSOC policies.

Supplementary material. To view supplementary material for this article, please visit https://doi.org/10.1017/dmp.2023.53

Competing interests. The authors have no conflicts of interest to disclose.

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