BRIEF REPORT

OPEN

The Role of a Statewide Critical Care Coordination Center in the Coronavirus Disease 2019 Pandemic—and Beyond

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OBJECTIVE: Public health emergencies, like the coronavirus disease 2019 pandemic, can cause unprecedented demand for critical care services. We describe statewide implementation of a critical care coordination center designed to optimize ICU utilization. To describe a centralized critical care coordination center designed to ensure appropriate intensive care resource allocation.

DESIGN: A descriptive case series of consecutive critically ill adult patients.

SETTING: ICUs, emergency departments, freestanding medical facilities in the state of Maryland and adjacent states, serving a population of over 6,045,000 across a land area of 9,776 sq mi (25,314 km^2).

PATIENTS: Adults requiring intensive care.

INTERVENTIONS: Consultation with a critical care physician and emergency medical services clinician.

MEASUREMENTS AND MAIN RESULTS: Number of consults, number of patient movements to higher levels of critical care, and number of extracorporeal membrane oxygenation referrals for both patients with and without coronavirus disease 2019. Over a 6-month period, critical care coordination center provided 1,006 critical care consultations and directed 578 patient transfers for 58 hospitals in the state of Maryland and adjoining region. Extracorporeal membrane oxygenation referrals were requested for 58 patients. Four-hundred twenty-eight patients (42.5%) were managed with consultation only and did not require transfer.

CONCLUSIONS: Critical care coordination center, staffed 24/7 by a critical care physician and emergency medical service clinician, may improve critical care resource use and patient flow. This serves as a model for a tiered regionalized system to ensure that the demand for critical care services may be met during a pandemic and beyond.

KEY WORDS: coronavirus disease 2019; critical care coordination; critical care organization; pandemic; regionalization

DOI: 10.1097/CCE.0000000000000568

Public health emergencies may cause unprecedented demand for critical care services. This requires thoughtful, proactive resource management strategies. ICUs must be used for patients most in need to optimally manage scarce resources (1). In this brief report, we describe statewide implementation of a critical care coordination center (C4) designed to optimize ICU utilization. This integrated and comprehensive public safety-based model coordinated care between hospitals to ensure that the "right patient received the right care in the right time."

METHODS

Recognizing the need for centralized critical care, the Governor of Maryland authorized funds to staff C4 based at the Maryland Institute for Emergency Medical Services System (MIEMSS). MIEMSS is an organization that oversees and coordinates the statewide emergency medical services (EMSs) system.

A central intensivist physician (CIP) and critical care coordinator were available 24/7 for immediate consultation. A CIP is a critical care physician with situational awareness of critical care beds, ventilators, and additional critical care resource availability (2) throughout the state. CIPs were required to be actively practicing board-eligible intensive care physicians who spent a minimum of 800 dedicated hours per year in an ICU. Requests for CIPs were communicated to hospital leaders throughout the state, members of the Baltimore chapter of the Society of Critical Care Medicine, and the National Institutes of Health (located in Bethesda, MD). CIPs were chosen from all major health systems in order to maintain a balanced roster that would represent the interests of all hospitals throughout the state. Critical care coordinators were EMS clinicians (emergency medical technicians and paramedics) with intimate knowledge about statewide regional critical care capabilities. The CIP and critical care coordinators worked closely with existing state and hospital-/system-level incident command systems and leaders to ensure optimal distribution of patients and transport of patients to the most geographically proximal ICUs. Databases were created using Smartsheets (Smartsheet, Bellevue, WA) and Tableau (Salesforce, San Francisco, CA) with automated hourly ICU census feeds provided by a health information exchange system (Chesapeake Regional Information System for Our Patients, Columbia, MD). A map was created to depict hourly ICU census. A medical director was appointed to coordinate and synchronize all C4 operations, with additional oversight provided by the Executive Director of MIEMSS and the System Chief of Critical Care for the University of Maryland Medical System.

The C4 was involved in requests for transfer to hospitals with ICUs throughout the state. Additional roles of the C4 included the following:

- Medical oversight/triage for interfacility critical care transports.
- Coordination of specialty and subspecialty services (i.e., extracorporeal membrane oxygenation [ECMO], continuous renal replacement therapy, and advanced mechanical ventilation).
- Medical direction and coordination for high-risk critical care transport (when medical direction by assigned transport agencies was not available).
- Medical oversight/coordination for repatriation of recovering patients back to referring institutions or alternative destinations.

RESULTS

Using an EMS-based public safety platform, over a 6-month period, the C4 provided 1,006 critical care consultations and directed 578 patient transfers (57%) for a population of over 6,045,000 in the state of Maryland and adjoining region. Two-hundred fifty-six patients (25.4%) had coronavirus disease 2019 (COVID-19); 51 patients were persons under investigation for COVID-19. ECMO referrals were requested for 58 patients; of these, 50 (86%) were cannulated. Four-hundred twenty-eight patients (42.5%) were managed with consultation only and did not require transfer. Transfer locations were geocoded and tracked with a heat map for both COVID-19 and non–COVID-19 patients to monitor regional volumes (**Fig. 1**). Initial costs, including procurement of computers, software, and telephone systems, totaled $6000 U.S. dollars (USD). Recurring costs were $4,320 USD per

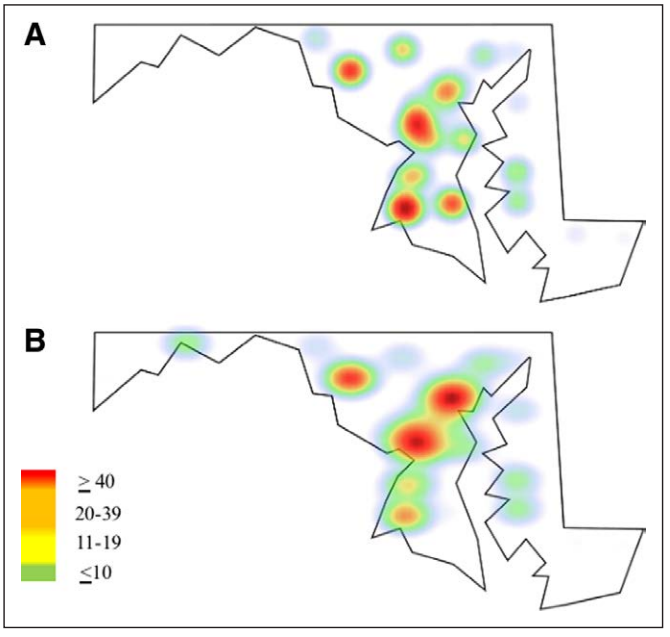

Figure 1. Heat map depicting noncoronavirus disease 2019 (COVID-19) ICU transfers (**A**) and COVID-19 ICU transfers (**B**) coordinated by critical care coordination center, November 30, 2020, to May 9, 2021. Note: figure only represents in-state ICU transfers.

day, later reduced to $2,920 USD per day after a fee-for-service model was implemented (coordinators and CIPs were payed a reduced flat fee for a 12-hr shift with additional compensation for each consultation).

DISCUSSION

A fundamental mission of critical care organizations is assuring that the right patient receives the right service at the right time and in the right place by the right caregivers (3, 4). Regionalization is defined as the "systematic concentration of selected patients in a subset of centers of excellence" through the establishment of a network of resources that deliver specific care to a defined population of patients (5, 6). Regionalization helps organize care by using protocols or care pathways and by providing a site for definitive procedures recognizing geographic needs with the goal of providing higher value care (7). During standard operations, most transfers stay within a single healthcare system. When there is an accelerated need for critical care, such as during a pandemic, critical care resources may be limited; hence, regionalization may help. This may require transfers between healthcare systems. However, this usually requires a hospital to "go shopping" for an accepting institution. This is often difficult, particularly when specialty services such as ECMO may be needed. To our knowledge, this is the first report of a public safety-based C4 staffed by intensivists and paramedics with the objective of regionalizing critical care resources.

Tiered approaches to regionalization have been applied extensively in trauma and neonatal care. Numerous studies demonstrate that transfer of critically ill patients to high-volume regional centers is associated with lower mortality rates for a wide variety of conditions (8–10). The implementation of C4 was advantageous for several reasons. First, the C4 used an existing statewide public safety EMS organization. Such an infrastructure with robust communications, medical direction, and EMS clinicians with intimate knowledge about statewide regional critical care capabilities had immediately realizable benefits. Second, transfers were affected over multiple hospital systems. This allowed for efficient use of resources. Most community hospital ICUs became quite facile at managing COVID-19–related diseases. Some, like severe respiratory failure that required advanced ventilator care or ECMO, needed care in regional centers of excellence. When beds were occupied by COVID-19 patients, other critically ill patients required transfer as there were insufficient beds to provide care for all patients. Interestingly, over 40% of consults did not require transfer. Often intensivists and/or families simply needed to know that the local care was sufficient. Third, CIPs were selected from critical care organizations throughout the state. CIPs provided 24/7 consultation which prevented unnecessary movement and inappropriate critical care utilization. Fourth, critical care transport resources were limited. Some patients requiring expeditious transfer to higher levels of critical care. C4 staff maintained situational awareness of all critical care capacity throughout the state, enabling raid transports when needed.

Throughout the implementation of this complex and far-reaching program, several challenges had to be overcome. Some hospitals were reluctant to participate initially since referral patterns were altered. For example, some community hospitals with ICUs were not accustomed to receiving patients directly from outside emergency departments. Through continuous engagement with hospital leaders and by ensuring representation in the C4 by recruiting CIPs from these hospitals, reluctance to accept nontraditional transfers rapidly dissolved. Many hospital systems in the state of Maryland had preexisting networks with coordination centers. The C4 was initially regarded as a redundant system by some of these systems. This misperception was overcome by ensuring equal representation of CIPs from each system and through direct engagement with coordination center leaders. It was made clear that the objective of the C4 was not to usurp the authority and organization of existing hospital system coordination centers but to augment these centers, including assistance with routing patients from other hospitals toward these systems. Furthermore, a standard operating procedure was created to ensure that CIPs and coordinators worked to keep system hospitals in the same system whenever possible, depending on capacity. Emergency physicians were not accustomed to "one-call" consultations for critical care requests; many emergency physicians had established call lists and relationships with local system hospitals. The C4 rapidly gained support from emergency physicians—especially from physicians and providers working in stand-alone emergency departments—due to the ability of the C4 to maintain overall

situational awareness of all hospital systems and critical care capacity across the state.

CONCLUSIONS

We describe the statewide implementation of a C4 designed to optimize ICU utilization. This public safety-based system is a model for a tiered regionalized system designed to ensure that the demand for critical care services may be met during a pandemic and beyond.

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The authors have disclosed that they do not have any potential conflicts of interest.

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