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Editorial

Critical Care During the Coronavirus Crisis: Challenges and Considerations for the Cardiothoracic and Vascular Anesthesia Community

THE CORONAVIRUS pandemic has challenged healthcare globally, resulting in more than 1 million cases worldwide with an estimated mortality rate of 5% to 10%.[1,2] Although the clinical presentation is often mild- to- moderate in severity, many will develop critical disease that requires admission to an intensive care unit.[3-5] The severe clinical presentations in coronavirus disease-2019 (COVID-19) include acute respiratory distress syndrome, cardiogenic shock, septic shock, disseminated intravascular coagulation, and renal failure.[3-7] The novelty of this infection, its infectious potential, and its clinical consequences have generated a surge in demand for critical care services that include unique considerations for echocardiography and extracorporeal membrane oxygenation (ECMO), both in adult and pediatric practice.[5-9]

The purpose of this freestanding editorial is to highlight the challenges and considerations in the critical care response to COVID-19. The suggested strategies have outlined options for designing best practices to navigate the coronavirus crisis successfully. The provided references also can serve as a guide for policy leaders to frame their plans for meeting the demands of the pandemic at their respective institutions.

Consider the Challenges in Critical Care for Acute Respiratory Failure

The hazards of advanced airway management, including endotracheal intubation, in patients with COVID-19 include infection as a result of the aerosolization of viral particles.[10] The focus on infection control during airway management in this setting for patients includes limited mask ventilation, full barrier precautions, limited operators, and dedicated airway teams.[11,12] These important considerations apply to all aerosolizing procedures, including bronchoscopy and transesophageal echocardiography, and the clinical care of these patients in the interventional suite and operating room environments.[10-13]

The leadership of ECMO services during this pandemic should design strategies to manage the personnel, equipment, facilities, and support systems for this life-saving therapy.[3-5,14,15] Although ECMO has been recommended in patients with COVID-19 by the World Health Organization, recent guidelines from the Extracorporeal Life Support Organization have highlighted that this modality should be used in experienced centers as a rescue strategy for severe acute respiratory distress syndrome.[3-5]

Despite the initial recommended approaches for acute respiratory distress syndrome associated with COVID-19, overall oxygenation may deteriorate clinically as reflected by a decreasing blood oxygen tension/inspired oxygen ratio.[14,15] When this important ratio decreases to less than 150 mmHg, it should trigger consideration of the following acute care interventions to improve gas exchange: lung recruitment maneuvers, positive end-expiratory pressure titration, neuromuscular blockade, and prone positioning.[3-5] Inhaled selective pulmonary vasodilators such as nitric oxide and epoprostenol may be considered in specialized centers to further optimize matching of ventilation and perfusion throughout ventilated lung areas.[3-5]

If this ratio decreases to less than 75 mmHg for 3- to- 6 hours and/or the arterial pH persists at less than 7.25 with a carbon dioxide tension more than 60 mmHg despite maximal medical therapy, then ECMO should be considered.[3-5] The contraindications for ECMO in patients with COVID-19 should be hospital-specific, with consideration of local factors such as team experience and resource availability.[14,15] Clinical risk factors such as advanced age, frailty, prior lung disease, diabetes, heart failure, and immunosuppression also may qualify as contraindications to ECMO.[14-16] The indications and contraindications to ECMO during the coronavirus crisis should be adjusted in real time to local factors.

Consider the Challenges in Critical Care for Acute Cardiovascular Failure

The cardiovascular challenges associated with COVID-19 are significant and merit specific focus by the acute care teams that may include members of the cardiothoracic and vascular anesthesia community.[7] The coronavirus infection may

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directly infect the heart and result in acute myocarditis with cardiogenic shock and pericarditis with effusion and tamponade.[7] The clinical spectrum of cardiac involvement in severe COVID-19 includes acute coronary syndromes, clinically significant arrhythmias, right ventricular failure, and/or vasoplegic shock from multiple etiologies including patient-specific and virus-specific factors.[4-7] These cardiac manifestations often can be diagnosed with serial bedside echocardiography by experienced operators who have adapted the conduct of the examination to these challenging circumstances.[8,13]

In the event of cardiac arrest, the conduct of advanced life support in adults, children, and neonates can be challenging and requires significant adjustments.[17-19] From the trainee perspective, the following issues have been raised in this clinical setting: safety of the institutional protocols; clarification of risk factors for mortality to guide risk stratification; planning and procedures to withhold this resuscitation from patients in accordance with their wishes; and, finally, additional national guidance about these issues.[18,19] As a response to this call for a national conversation, the American Heart Association recently updated its guidelines for basic and advanced life support in light of COVID-19.[18] This multisociety guideline recommended multiple adjustments to the protocols for cardiopulmonary resuscitation in 3 major categories as follows: (1) minimize provider exposure, (2) emphasize airway and ventilation strategies to minimize aerosolization risk, and (3) consider the appropriateness of resuscitation.[18,19]

In the first group of considerations about exposure control, this guideline recommended clear and comprehensive communication, protocols for limiting personnel, meticulous use of personal protective equipment, and consideration of mechanical devices for chest compressions.[18] In the second group of considerations about control of aerosolization, the guideline recommended airway filters, lower thresholds for endotracheal intubation, video laryngoscopy, experienced operators, limiting of bag-and-mask ventilation, and minimizing disconnects of the closed circuit components.[18] In the third group of considerations about appropriateness of resuscitation, the expert consensus recommended that the goals of care be addressed whenever possible, including institutional indications for cardiopulmonary resuscitation in COVID-19.[18] This clarification about goals of care may require input from the palliative care service in selected cases as part of a systematic institutional response to the COVID-19 pandemic.[20-23]

In the event of cardiogenic shock refractory to medical management, consideration of mechanical circulatory support could be made, including venoarterial ECMO.[3-7] The management of personnel in the delivery of ECMO services at an experienced center should be centralized, with flexible staffing models to accommodate staff attrition.[3-5] Experienced centers also may have to advise referring centers to accommodate unique aspects of COVID-19, including referral indications, transport protocols, and infection control.[3-5] Furthermore, patients with COVID-19 who require cardiopulmonary support with ECMO may be grouped into cohorts in designated hospital areas that are resourced appropriately to care for these patients.[3-5]

Consider the Challenges in Surge Planning for Critical Care

The preparation process for the critical care demands of the patient with COVID-19 can be structured according to established models for pandemics, with due consideration of the general parameters and relevant specific parameters such as high-risk populations.[24,25] The management of the critical care service line during the coronavirus crisis ideally should be part of the coordinated response from the health system.[24,25] The magnitude of the expected surge can be classified into 3 phases (3C response model: conventional/contingency/crisis).[24] The first phase is characterized by a minor surge in the 20% to 40% range and typically is handled in a conventional fashion with response strategies such as conservation and substitution.[24,25] The second phase is characterized by a moderate surge in the 80% to 100% range and typically is handled in a contingency fashion with response strategies such as conservation, substitution, and adaptation.[24,25] The third phase is characterized by a severe surge in the 180% to 200% range and typically is handled in a crisis fashion with all response strategies such as conservation, substitution, adaptation, reuse, and reallocation.[24,25]

The adaptation process thus can be understood in terms of the pandemic intensity at a given health system, with conventional, contingency, and crisis phases.[24,25] A second important framework for designing a surge response is the process of temporal triage that is based on patient flow.[24] In primary triage, the priorities for patient management are decided in the prehospital phase before the patient reaches the health system in question. In secondary triage, the priorities for patient management typically are decided on arrival to the hospital, most typically in the emergency department.[24,25] In tertiary triage, the priorities for patient management continue in a definite clinical venue such as the intensive care unit and/or the operating room.[24,25] The matrix for approaching the coronavirus crisis thus can be framed with respect to intensity via the 3C model and with respect to patient flow via the 1-degree/2-degree/3-degree triage model.

A flexible critical care strategy therefore should be indexed to the phases of the coronavirus pandemic and be centralized with designated triage officers and triage policies.[22-25] The surge response will necessitate thoughtful adaptation to recruit critical care capacity across the health system, including coalition with neighboring hospitals as needed.[22-25] These strategies to develop surge capacity may require postponement of elective surgeries and interventional procedures; centralized acute care for COVID-19 patients in designated units; and consideration for new critical care space, including the operating room suites and postanesthesia care units. The surge strategy also should include resilient and synergistic techniques within and across medical centers to manage system issues such as clustering of cases, infection control, patient transport, and waste management.[22-25]

Consider the Challenges in Critical Care Staffing and Supplies

The critical care workforce should be expanded and supported through all phases of the pandemic with processes such as meticulous infection control, high-quality communication, and an engaged and approachable leadership team.[1,22] Furthermore, the critical care teams can be augmented with staff from allied departments (eg, cardiothoracic surgery, trauma, emergency medicine) and selected staff from the anesthesiology department. These new recruits at all levels will require adapted training and education with appropriate simulation exercises, workshops, and short courses.[1,22-25] The attrition of staff because of illness, vacation, and quarantine should be tracked and managed carefully and transparently in real time. Acute shrinkage in the critical care workforce also can be minimized with detailed plans for infection control, social distancing, vacation limits, and travel restrictions within a flexible framework that can be adapted and indexed to the intensity of the pandemic in real time.[1,22]

The management of critical care supplies remains essential to facilitate a smooth supply process for all these resources during the surge phases of the pandemic.[22,23] There should be a transparent record-keeping system to track hardware movement throughout the health system in real time. This hardware management process should be centralized to document reserves, to control waste, and to avoid local hoarding.[1,22] In the setting of an ECMO service line, this centralized registry should include ECMO hardware supplies. The integration of simulation into the clinical learning environment can greatly enhance best practices for appropriate utilization in the hardware line for all team members engaged in the response to COVID-19 throughout a given health system.[1,22-25]

Mechanical ventilators are an essential part of the hardware line for the critical care surge response to COVID-19 and as such may have to be triaged during the crisis phase of the pandemic.[26] The Centers for Disease Control and Prevention recently issued guidance for the allocation of ventilators across a healthcare region.[27,28] The first recommendation is to assess the ventilator demand based on data tracking and subsequent modeling to predict the number of patients who likely will require ventilation.[27-29] The ventilator gap then can be calculated as the difference between this estimated ventilator demand and the number of ventilators immediately available, including locations outside the intensive care units such as the operating room environment (ventilator supply).[27,28] The second recommendation is to assess the capacity for additional ventilators at a given institution after considering factors such as staffing, equipment capacity, and physical space. The third recommendation is to consider equal access across the health region, including factors such vulnerable populations, high-risk populations, and referral centers.[24-28] The fourth consideration is to develop and apply an ethical framework to maximize patient salvage with transparent and consistent criteria, given the limited resources.[24-28] The concept of sharing a single ventilator for multiple patients also has been proposed as a solution to increase ventilator capacity during this coronavirus crisis.[30,31] A device for sharing a ventilator in this fashion recently received emergency approval from the US Food and Drug Administration.[32]

Consider the Challenges in Maintaining Resilient Support Systems

The support systems for the surge in critical care services during the pandemic of COVID-19 should focus on the physical and psychological safety of the personnel who may or may not have been in the intensive care unit environment on a regular basis before the crisis.[33-35] A focus on shared and transparent communication is essential. Important updates could be conveyed on a daily basis to the teams via multiple platforms, including virtual meetings, a telephone hotline, text-based messages, and e-mail groups.[33-35]

The support of the healthcare teams and their families is essential to navigate the coronavirus crisis successfully.[33-35] The negative psychological effects of the crisis can include exhaustion, confusion, anger, burn-out, substance abuse, and post-traumatic stress disorder.[33-36] The stressors that can significantly increase these adverse effects on psychological well-being include crisis duration, crisis intensity, disruptions in leadership, breakdowns in communication, financial concerns, and possible stigmatization.[32-35] The acknowledgment, sharing, and solving of these stressors will allow the teams to navigate the crisis in an agile and resilient fashion.[32-35]

Conclusions

The crisis from COVID-19 has challenged the delivery of high-acuity care worldwide. The resulting surge in critical care demand has a typical natural history. A successful response strategy will approach acute cardiopulmonary care and the workforce in the setting of adequate supplies and support. A sustained focus on infection control remains essential.

Conflict of Interest

None.

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