Necessity of Cardiothoracic Surgical Critical Care Medicine Training

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Cardiothoracic surgical critical care medicine is practiced by a diverse group of physicians including surgeons, anesthesiologists, pulmonologists, and cardiologists. With a wide array of specialties involved, the training of cardiothoracic surgical intensivists lacks standardization, creating significant variation in practice. Additionally, it results in siloed physicians who are less likely to collaborate and advocate for the cardiothoracic surgical critical care subspeciality. Moreover, the current model creates credentialing dilemmas, as experienced by some cardiothoracic surgeons.

education cardiothoracic surgery intensive care medicine

1. Introduction

Cardiothoracic surgical critical care medicine (CT-CCM) remains unrecognized as a specific subspeciality of critical care medicine (CCM) [1]. Nonetheless, CT-CCM is currently practiced by a diverse group, including anesthesiologists, cardiothoracic surgeons, internists, cardiologists, and emergency department physicians [2]. As a result, there is a marked variation in CT-CCM training between specialties and fellowship programs, with an overall lack of standardization [1][2][3][4]. For example, anesthesiology critical care fellows typically spend 2–6 months in cardiothoracic intensive care units (CT-ICUs) during training [5]. In contrast, internal medicine critical care fellows rotate through CT-ICUs in the second year of training on an elective and optional basis. Cardiothoracic surgery (CTS) fellows, on the other hand, round and follow their ICU patients throughout the entirety of CTS training, but specific critical care education varies significantly and, accordingly, critical care knowledge may be inadequate. Further, there is no official requirement for ICU rotations or rotations under CCM trained faculty in the traditional training pathway. Instead, cardiothoracic fellows who have the desire to practice independently in CT-CCM typically enter a surgical critical care fellowship and focus their experience on CT-CCM [6][7][8]. Consequently, CT-CCM training is subject to institutional culture, in-unit expertise, and specialty-related biases.

The lack of standardization and official recognition of CT-CCM has significant ramifications. First, competency in CT-CCM skills varies between graduates of different programs, creating inconsistent standards and quality of CT-CCM care. Second, intensivists siloed by particular specialties are less likely to collaborate and advocate for CT-CCM as a whole. Compartmentalized critical care experiences–either within only CT-CCM (e.g., for cardiothoracic fellows), or only medical ICU experiences (e.g., some medical fellows)-limits growth and stifles the scientific inquiry needed to advance CT-CCM. Lastly, credentialing difficulties can result where, for example, cardiothoracic surgeons without an official CCM fellowship are unable to gain ICU privileges [6].

As a result, overcoming these limitations in CT-CCM intensivists training requires strong leadership. While cardiothoracic surgeons often claim ownership of the CT-CCM realm because of an appropriate sense of responsibility for patients, on whom they operated, and perceived expertise in the field, the delineation of training standards required to achieve competency in CT-CCM or standardizing dual training in critical care and CT surgery has not occurred [2][3][4][6][9]. On the other hand, critical care anesthesiology has been expanding in the U.S. with a typical emphasis on practice in cardiothoracic critical care [10]. Notably, the coronavirus disease 2019 (COVID-19) pandemic further brought anesthesiologists to the forefront of critical care due to successful leadership in initiatives, such as CAESAR-ICU, anesthesia machine repurposing, and volunteer staffing of COVID-19 intensive care units [11][12]. Moreover, critical care anesthesiologists expanded their specialty's footprint in cardiothoracic surgical critical care units (CT-ICUs) by providing very specific care for the sickest COVID-19 population, including care of patients supported with extra-corporeal membrane oxygenation (ECMO) and lung transplantation recipients [13]. Therefore, the specialty of anesthesiology has a unique and historical opportunity to continue the innovative approach for critical care exemplified during the pandemic.

Anesthesiologists are well-positioned to lead cardiothoracic CT-CCM initiatives. General, cardiothoracic, and critical care anesthesiology training provide physicians with skills and the bandwidth distinctively suited for CT-ICU care [1][14][15]. Moreover, anesthesiologists presently make up a large fraction of CT-CCM intensivists and are particularly adept at multidisciplinary collaboration, which is crucial to the outcomes in the CT-ICU [10].

2. Why Is CT-CCM Specific Training Needed?

As the complex perioperative environment of cardiothoracic and vascular surgery evolves, so does the need for physicians specialized in managing these critically ill populations [14]. The wisdom and competence required to navigate the difficult perioperative ecosystem of a CT-ICU are laborious to develop and surpass the learning of any single skill or ability. Current CT-ICU practices are the pinnacle of medical science, integrating core critical care concepts with evolving devices, extra-corporeal support, and transplant considerations. Extra-corporeal life support (ECLS), durable mechanical circulatory support (DMCS), cardiac surgical unit advanced life support (CSU-ALS), point-of-care ultrasonography (POCUS), ethical challenges, and team management are just a few examples of complexities encountered in CT-ICUs. This section describes unique aspects of CT-CCM with specific examples that illustrate why specific, focused training is necessary.

2.1. ECLS

ECLS is primarily utilized and managed in CT-ICUs [16]. In effect, best trained CT-ICU intensivists must be ECLS specialists with an intimate familiarity in patient selection, cannulation strategies, management, and destination therapy selection. This unique intersection between critically ill patients and the utilization of extra-corporeal membrane oxygenation (ECMO) was fully realized through the efforts of cardiothoracic intensivists during the COVID-19 pandemic [17]. CT-ICU physicians triaged patients for ECMO candidacy, in some centers, cannulated them, then managed the ECMO circuit, and finally, assisted with patient selection for lung transplantation [17][18][19]. They also provided specific scientific expertise related to ECMO physiology. A particular example of CT-CCM competence benefiting patient care was the management of hypoxemia in patients with COVID-19 supported with ECMO. Many physicians followed absolute oxygen saturations and partial pressure of oxygen values while on ECMO instead of using oxygen carrying capacity, delivery, and consumption [20][21]. This may have resulted in the unnecessary treatment of hypoxia with heavy sedation, prone positioning, and beta-blocker therapy, even when oxygen delivery met metabolic demands [20][21]. Distinct knowledge possessed by well-trained CT-ICU intensivists allowed for the avoidance of these unnecessary maneuvers and their associated risks [22].

However, the COVID-19 disease plays only a small part in overall competence in ECMO support. Many other complexities exist. For example, CT-ICU physicians need to be versed in the components and various configurations of ECMO for both respiratory and circulatory failure [23][24]. An appreciation of the difference between cannulation arrangements, such as veno-arterial-venous (VAV) vs. veno-venous-arterial (VVA), is crucial; although seemingly similar in terminology, the indications and effects of each configuration are strikingly different [25]. Additionally, the optimal use of other life support devices, including mechanical ventilation and renal replacement therapies, requires an understanding of the interactions among them and how to optimize their use to ensure the best outcomes for the patient and avoid unnecessary risk. For example, the strict optimization of lung rest and the avoidance of ventilator-induced lung injury for patients with respiratory failure on ECMO is crucial for improving outcomes [26]. Moreover, drug sequestration in the circuit and oxygenator is a known issue which can alter the pharmacokinetics and pharmacodynamics of frequently used medications [27][28]. Knowledge of pharmacologic interactions of the ECMO circuit while tailoring medical therapeutics in line with best practices in critical care medicine is essential for clinicians caring for ECMO patients. Finally, while rare, the CT-ICU clinician must be able to respond rapidly to mechanical emergencies related to the circuit that are life-threatening, which include but are not limited to: circuit disruption, oxygenator failure, raceway rupture, cavitation, system or component alarm and failure, air embolism, and inadvertent decannulation and clots [29].

As ECLS services continue to expand, standardized education and training are required to provide clinical quality and competency control. Certification exams and workshops delivered by the Extracorporeal Life Support Organization (ELSO) are a good start in this process, but insufficient to truly train a competent practitioner. Extended, hands-on clinical training and mentorship in concert with a certification process are a priority.

2.2. CSU-ALS

The complexities of care in the CT-ICU are not just limited to mechanical devices and organ failures. Advanced cardiac life support (ACLS) after cardiac surgery differs from ACLS provided in any other setting. CSU-ALS is an altered ACLS protocol explicitly designed for the resuscitation of patients after cardiac surgery [30]. Some important differences include an initial deferral of chest compressions in favor for the fast defibrillation of malignant arrhythmias, reduction of epinephrine bolus doses, disconnection of pacer wires, cessation of infusions, prompt chest opening for manual cardiac massage and tamponade relief, and rapid application of ECLS, if necessary [30]. Multidisciplinary teams adapted to the new ACLS paradigm are required to certify, display appropriate skills and competence, and recertify every 2-years. With more data coming out relating to the benefits of CSU-ALS, training physicians with an intimate knowledge and interest in these procedures is paramount for patient care and the advancement of research in the perioperative resuscitation of cardiac surgery patients.

2.3. POCUS

The role of critical care ultrasonography in diagnosing and managing CTICU patients continues to expand [31]. With the recent improvement in the availability of surface probes and the portability of ultrasound machines, the indications for use in CT-CCM have extended beyond cardiac assessment. Focused clinical assessments of the lungs, diaphragm, airway, gallbladder, kidneys, blood vessels, and optic nerve sheaths have been increasingly utilized in critical care [31]. This advancement has now transformed bedside diagnostics. For example, ultrasound is now more sensitive for diagnosing a pneumothorax than a chest radiograph [32]. Yet another example, the size of the optic nerve sheath can be used for the evaluation of an intracranial pressure [33]. These skills are fundamental to patient care in current CT-ICUs.

2.4. Team and Leadership Skills

In the highly specialized ecosystem of CT-CCM, knowledge is crucial, but insufficient for the successful maturation of a competent CT-CCM intensivist. CT-CCM training must also tackle scientific literacy, ethical conduct, managerial competence, and interpersonal skills, as these are especially important for care excellence in this setting [14][19][34][35]. CT-CCM requires special scientific considerations and inquiry as the pathophysiology and mechanisms of injury often differ from patient populations in other ICUs. Consequently, CT-CCM is in dire need of physician-scientists who can answer the most pressing CT-ICU questions. Training physicians in an environment where CT-CCM distinction is appreciated is likely to produce intensivists interested in expanding knowledge unique to the field. Additionally, ensuring intimate familiarity with four ethical principles and their application in CT-ICU is paramount. CT-ICUs are especially ethically challenging due to high risk of complications and mortality [36]. Moreover, significant resource utilization, 30-day public mortality reporting, and the emotional involvement of the medical team can affect shared decision-making [37][38]. As a result, trainees need to learn how to navigate ethically difficult situations specific to CT-ICUs. Lastly, managerial skills are a necessity given the expansion of advanced practice practitioners and their strong presence in surgical teams; intensivists need to be trained with ample yet supportive supervision [39]. Additionally, juggling competing opinions from all of the stakeholders along with conflict management are crucial for patient safety, yet again highlighting the importance of executive competence [34][35].

In summary, developing wisdom and competency in CT-CCM require specific education and mentorship. CT-CCM is complex, challenging, and cognitively and emotionally taxing. Hence, subspecialty training is necessary to develop physicians who are competent intellectually and behaviorally to lead large, complex teams, provide the highest level of care, and advance CT-CCM as a medical science efficiently and effectively.

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