The field of cardiovascular medicine is constantly evolving. New discoveries in molecular cardiology, cardiovascular genomics, and physiology have culminated in the development of improved diagnostic methods and treatment advances, the results of which have allowed us to extend the lives of our patients. Millions of dollars, from both government and industry, currently fund countless studies in prevention, advanced cardiac imaging, and novel interventional therapeutics, to name just a few. However, there is an area of cardiovascular medicine that has been largely overlooked; an area so vitally important to our nation’s economy but thus far given very little attention in terms of research support, physician education, and public awareness. Despite being one of the largest and most expensive aspects of U.S. health care, representing an area of patient demand growing at a rate far exceeding that of physician supply, we have done little as of yet, as a discipline, to address the burgeoning crisis of critical care.

The care of critically ill patients accounts for approximately 1% of the gross domestic product in this country (1). Despite finding ourselves in this already profound economic predicament, we know that the aging of the U.S. population will only lead to additional predictable increases in the demand for critical care services (2). At the same time, as it stands now, the supply of physicians trained to provide effective critical care will remain constant. Therefore, it has been estimated that by 2020 there will be a deficit of intensivists that is equal to 22% of demand, and by 2030 this deficit will approach 35% (3).

Whereas other intensive care units (ICUs) have been traditionally staffed by physicians who are board-certified in critical care medicine, we have never dictated that our own coronary care units (CCUs) be managed by cardiologists with advanced training in the care of critically ill patients. It is only a matter of time, however, before the cardiovascular community faces challenges to this long-standing tradition. It will be our response to these challenges that will profoundly shape the future of our field.

**Evolution of the CCU**

The first description of the CCU was presented by Julian to the British Thoracic Society in 1961 (4). Soon after, the first CCU was established in the U.S., followed shortly by a landmark study from Killip and Kimball (5) confirming the importance of the CCU as a beneficial tool in the management of patients with acute myocardial infarction (MI). Although many point to that landmark study as the foundation for the modern-day risk-stratification scheme that bears their name, the often overlooked contribution of Killip and Kimball (5) was their ability to show demonstrable improvements in mortality for acute MI patients treated in a CCU rather than a regular ward setting. Largely driven by survival gains associated with the early recognition of life-threatening arrhythmias, those results were monumental in establishing the benefits of intensive care for the high-risk cardiology patient.

The landscape of the CCU today, however, has changed vastly from that of the 1960s. No longer is it simply an observation unit for patients with acute MI, but rather it has...
become a dynamic and diverse arena of patient care. Today’s prototypical CCU patients include those with complicated and uncomplicated MI, decompensated heart failure and frank cardiogenic shock, severe valvular heart disease, high-grade conduction disturbances, incessant ventricular arrhythmias, complications of percutaneous procedures, and sequela of intravascular device infections. Increasingly in modern medicine, these conditions are not seen in isolation but rather in connection with a series of additional medical comorbidities. As a result, now more than ever before, the distinctions between our CCUs and traditional medical ICUs have become increasingly blurred. The cardiologist is being called on to care, at the onset, for patients with multiple critical care issues, often because their cardiac problems are perceived to be paramount at initial triage. Furthermore, patients in the CCU are subject to the same nosocomial complications seen in other intensive care settings, and therefore CCU cardiologists must now be adept in the management of acute lung injury, prolonged ventilation and ventilator weaning, delirium, renal replacement therapy, venous thrombosis, gastrointestinal hemorrhage, ICU polyneuropathy, and septic shock.

This striking medical diversity is quite apparent by observation of the patients currently occupying CCU beds in this country. A recently conducted nonvalidated review of several months at our institution revealed that, although acute coronary syndrome (ACS) was still the most common admitting diagnosis, respiratory failure, acute renal failure, mechanical ventilation, and sepsis have become increasingly more common over the last decade (Fig. 1). These trends highlight the overlapping populations between the contemporary CCU and other ICUs.

**The Call for Intensivists**

Several retrospective studies were the first to show a benefit of intensivist staffing on patient outcomes in critical care settings (6,7). More specifically, the addition of board-certified critical care specialists was found to be temporally associated with improvements in both ICU and in-hospital

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**Abbreviations and Acronyms**

- **ACS** = acute coronary syndrome
- **CCU** = coronary care unit
- **ICU** = intensive care unit
- **MI** = myocardial infarction

**Figure 1**

**Trends in CCU Comorbidities and Therapies - 1996 to 2006**

Duke University Hospital coronary care unit July 1996, July 2001, and July 2006. CCU = coronary care unit; ESRD = end-stage renal disease; IABP = intra-aortic balloon pump; MI = myocardial infarction; PCI = percutaneous coronary intervention; VF = ventricular fibrillation; VT = ventricular tachycardia.
mortality. Other prospective studies in various ICU settings have corroborated these retrospective findings (8,9). Despite the limitations in conducting prospective randomized trials assessing intensivist impact on patient outcomes, there are now a multitude of nonrandomized studies that support the notion that physicians trained in critical care not only can improve patient outcomes but also can improve the utilization of medical resources.

If the medical community has been slow to take note of these findings, health care and business organizations have not. The Leapfrog Group, composed of more than 170 public and private organizations that provide health care benefits to approximately 37 million people, has recently embraced the challenge of improving U.S. critical care delivery (10). They believe that all ICUs should be managed exclusively by dedicated intensivists, and many health care organizations, hospitals, and government agencies are already attempting to adhere to their proposed standards. With medical and surgical ICUs now beginning to feel the effects of these sweeping changes, it is hard to believe that our CCUs will be immune to this critical care reform.

Training Cardiovascular Specialists in Critical Care

Given the breadth of critical care diseases and the remarkable patient diversity now seen in our CCUs, we should anticipate an imminent challenge to the general cardiologists that currently staff these units and a call for dedicated intensivists to assume care for these complex patients. At the same time, there will be a significant shortage of physicians trained in critical care who will be available to meet these demands. By recognizing these shortcomings now and preparing our cardiology trainees to become certified in critical care medicine, we can both protect our interests as a discipline and help to avert a desperate impending crisis in the care of critically ill patients in our country.

The American College of Critical Care Medicine suggests that requisite training in critical care, although traditionally seen as an extension of postgraduate training in the fields of pulmonology, general surgery, and anesthesiology, should “encompass all disciplines that provide services in the ICU” (11). The care of critically ill patients with primary cardiovascular diseases in the CCU is no exception, and in

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**American Board of Internal Medicine (ABIM) Training Requirements for Specialists in Cardiovascular Disease Seeking Critical Care Certification**

**Eligibility Criteria**
- Training conducted in Critical Care fellowship program within a Department of Medicine
- Completion of 3 years of accredited Cardiovascular Disease fellowship and certification by the ABIM

**Training Requirements**
- Completion of 1 year of accredited clinical fellowship training in Critical Care Medicine
- Up to 6 months of critical care medicine experience in Cardiovascular Disease and Critical Care Medicine training can be applied to admission for both examinations
- Minimum total full-time clinical training for dual certification in Cardiovascular Disease and Critical Care Medicine of 30 months

**Procedural Requirements**

**Required Procedures**
- Maintenance of an open airway
- Oral/nasal intubation
- Ventilator management
- Insertion and management of chest tubes
- ACLS
- Placement of arterial, central venous, and pulmonary artery balloon flotation catheters
- Calibration and operation of hemodynamic recording systems

**Suggested Procedures**
- Pericardiocentesis
- Transvenous pacemaker insertion
- Peritoneal dialysis management
- Fiberoptic bronchoscopy
- Peritoneal lavage
- Insertion of esophageal-gastric balloon for variceal bleeding tamponade

**Figure 2**

Current American Board of Internal Medicine Clinical Requirements for Advanced Critical Care Certification in Those With Cardiology Training

ACLS = advanced cardiac life support.
fact it is suggested that critical care trainees should demonstrate clinical competence in “cardiovascular physiology, pathology, pathophysiology, and therapy” (11). Under the current system, most trainees who sit for the critical care boards each year spend relatively little time in the CCU (especially considering the overall burden of cardiovascular disease in the population), resulting in legitimate training gaps in the management of many of these critical cardiovascular disease states and the interpretation of cardiac diagnostic modalities.

Figure 2 highlights the American Board of Internal Medicine clinical training requirements for cardiology trainees currently interested in advanced critical care certification and provides a potential framework for the development of a cardiovascular critical care training track.

Answering Research Questions in Critical Care

The marriage between cardiology and critical care would have lasting effects not just in direct patient care but also in the arena of medical research. The field of cardiology remains at the forefront of clinical and translational research, and as leaders in clinical investigation, the potential academic impact of our increased involvement in the care of critically ill patients cannot be overestimated.

Simply looking at things from a cost perspective, the burden of cardiovascular disease to the health care system is undeniably large. Furthermore, critical care services, which many of these patients require, is extremely expensive. Therefore, cost-effectiveness and quality of care analyses of CCU admissions are important areas of potential study.

As a common locale for the disposition of the sickest patients with cardiac disease, the CCU also provides easy access to a large number of patients with a high expected event rate, and would therefore be a truly fertile environment from which to conduct critical care research. Potential areas of research overlap all fields of cardiology, including imaging (e.g., noninvasive methods of hemodynamic monitoring), coronary ischemia (e.g., identifying and managing ischemia in the medically heterogeneous ICU population), heart failure (e.g., identifying risk factors for the development of left ventricular dysfunction in the setting of sepsis), and resuscitation (e.g., assessing the impact of critical care comorbidities on advanced cardiac life support outcomes). Furthermore, the creation of a multicenter CCU database/registry could become an extremely valuable resource for clinical investigative work and genomic studies.

Embracing the Challenges Before Us

It is clear that if we fail to take on the challenge of training our fellowship graduates in critical care medicine, the opportunity to treat these richly diverse and complex patients may soon be taken from us. Additionally, with the advent and explosive growth of newer heart hospitals designed specifically for the care of the cardiovascular patient, there will most certainly be a need for trained cardiac intensivists to staff their critical care facilities.

Although the American College of Cardiology has recognized the growing demand for advanced cardiovascular care in an aging U.S. population (12), and the American Heart Association has joined with several critical care and trauma societies to create the “Council on Cardiopulmonary, Perioperative and Critical Care,” neither one of these governing bodies has published a definitive position statement on the role of cardiologists in the critical care crisis. Perhaps a Bethesda conference, bringing together several disciplines to help formulate a strategy for the implementation of critical care training in cardiology, will help provide greater focus to this problem and help to ensure that our patients with advanced cardiovascular disease continue to get the best evidence-based care.

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