CRITICAL CARE

Emergency Medicine

SECOND EDITION

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CRITICAL CARE EMERGENCY MEDICINE

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"*Guérir parfois, soulager souvent, consoler toujours*"
—Ambroise Paré

I would like to dedicate this book to my father Dr. Jean Pierre Farcy for his love and for sharing his passion for medicine and life. Dr. Thomas M. Scalea for being a great mentor, teacher, and most of all a friend who is always there when I need guidance. To my Mother, Poeia, Eve, Frederic, and Sarah, for their patience, support, and unconditional love.
—David A. Farcy

To all those who have been influential to me: Terri, Anthony, Katherine, Victoria, and the extended Shock Trauma family.
—William C. Chiu

With much love to my wife, Seriti, and my boys, Sahm, Siahvash, and Kianoosh, whose patience and support make everything possible.
And with deep gratitude to my teachers, the patients, from whom I learned everything I know about medicine.
—John P. Marshall

To my amazing husband Jeff and children Ashley and David Osborn for their unwavering love and support. In loving memory of my mother Edna L. Medlin, who dedicated her life to education.To my father and brothers, W. Lee, Christopher and Mitchell Medlin for your love and encouragement. In appreciation of my mentors and educators, who provided the light of education and the example of ethics.
Most importantly, this book is dedicated to our patients and their families. To trust in our care enough to invite us into the most personal aspects of their lives, during their most vulnerable periods, is the greatest honor and responsibility any person or profession can be bestowed.

—Tiffany M. Osborn

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FOREWORD

Critical care by its very nature is a multidisciplinary disease. Virtually every critically ill patient requires input from a multiplicity of practitioners. Physicians in the ICU provide direct care, and orchestrate and coordinate care for all other practitioners who participate. Given this complexity, it is interesting to note that critical care has been a recent development. The first true multidisciplinary ICU was opened in 1958 at the Baltimore City Hospital, now named Johns Hopkins Bayview. It was also the first ICU that had 24-hour physician coverage.

Critical care was rapidly becoming its own discipline, yet it lacked efficient organization. In 1970, 28 physicians met in Los Angeles and formed the Society of Critical Care Medicine. The society's leaders and first three presidents were Peter Safar, an anesthesiologist; William Shoemaker, a surgeon; and Max Harry Weil, an internist. Throughout the 1970s, 1980s, and 1990s, these three disciplines represented the backbone of critical care in the United States.

As critical care began to develop, emergency medicine also began to develop as a real discipline. In 1961, Dr James Mills started a full-time emergency medicine practice in Alexandria, Virginia. The American College of Emergency Physicians was founded shortly after that, in 1968. Residency training began at the University of Cincinnati, followed by the Medical College of Pennsylvania, and then the Los Angeles County Hospital. Finally, in 1979, the American Board of Emergency Medicine was approved. Other institutions then developed emergency medicine residencies. Today, there are over 150 accredited programs. Fellowship training followed in subspecialties such as toxicology, pediatrics, and now critical care.

The link between emergency medicine and critical care seems natural—both require understanding of complex physiology. Practitioners in both specialties must understand a multitude of diseases, synthesize solutions for complex problems, and do this quickly. When I founded the Department of Emergency Medicine at SUNY Downstate and Kings County Hospital in 1991, we created a 4-year residency program that was heavy in critical care. However, I soon realized that emergency physicians who wanted to practice real critical care would need additional training. Thus, when I became the Physician-in-Chief at the R Adams Cowley Shock Trauma Center, I established a critical care fellowship designed for emergency physicians. The University of Pittsburgh had been training emergency physicians for some time in its multidisciplinary critical care fellowship. There are now over 100 fellowship-trained emergency physician intensivists. Over two-thirds of them are trained at either Shock Trauma or the University of Pittsburgh. Many graduates practice in major academic centers and now provide leadership roles in these institutions.

Emergency physician intensivists have become commonplace in ICUs. This will continue. Emergency physicians who wish to be leaders will need to be clinically excellent, academically productive, and superior educators. The current textbook goes a long way toward establishing emergency physicians as credible intensivists. Although not every chapter is written by an emergency physician, many are. The authors are emergency physicians who most of us expect to become the leaders in critical care. The book is unique, as it blends the perspective of a true intensivist with that of emergency medicine. The book is the first of its kind, and I predict it will become known as the standard reference for those emergency physicians, as well as others, who wish to understand the overlap between emergency medicine and critical care.

Despite the lack of board certification and many other local political impediments, some emergency physicians have embraced critical care clinically, academically, and now in this textbook. The role of emergency physicians in critical care remains controversial, but the controversy is not as sharp as it was at the beginning. Those of us who have been there from the beginning look forward to the day that there will be no controversy left at all.

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PREFACE

With great pleasure and appreciation, we present the second edition of *Critical Care Emergency Medicine*. This book is a dedicated resource for those who diligently provide care for the sickest patients in emergency departments and intensive care units around the world—you. The emergency physician defines the quality interface between emergency medicine and critical care. We are proud and honored to provide a trusted resource to your armamentarium.

This edition provides updated recommendations, addressing the challenges faced by the emergency physician practicing critical care on the front lines of health care every day. Much like our clinical practice, it is written collaboratively by emergency physicians and colleagues from trauma, critical care, infectious diseases and pulmonary medicine. We are fortunate and appreciative to have these national and international experts contributing to a resource that is now readily available to you anytime of the day or night.

We would like to express our deepest gratitude to Mary Bennett for her diligent review and editorial expertise, Executive Medical Editor Brian Belval, Senior Project Development Editor Regina Brown, Associate Project Manager Dinesh Pokhriyal, and the entire staff at McGraw-Hill for their countless hours of providing us with guidance, direction, and at times, editorial "resuscitation." A special thanks to former Executive Medical Editor Ann Sydor for her vision and dedication in making the first edition a reality.

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I

INTRODUCTION

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History and Update in Critical Care Certification

Brian T. Wessman • Kyle J. Gunnerson • Emanuel P. Rivers • Debra Perina

"Critical care medicine… quo vadis?"[1] (translation: where are you going?)

- Peter Safar, MD

"Current politics preventing emergency medicine from getting additional critical care medicine subspecialty certification is wrong."

- Dr. Peter J. Safar, *Careers in Anesthesiology: An Autobiographical Memoir,* 2000

Critical care is a continuum initiated by prehospital care, continues with emergency medicine (EM) resuscitation and stabilization, and culminates with intensive care unit (ICU) management.[1,3] Since the formation of the Society of Critical Care Medicine in 1970, a multidisciplinary approach, including EM, has been advocated for the practice of critical care medicine (CCM).[4] Today, emergency medicine physicians (EMPs) are actively pursuing formal critical care training and certification to join the existing ranks of board-certified intensivists.

EMERGENCY MEDICINE RESIDENCY TRAINING

EM and CCM require proficient acumen in treating life-threatening acute illness. EM focuses on the early hours of disease treatment while CCM is weighted toward more prolonged management within the ICU.[4] Graduates of EM residency programs are unique in their training and background, making them ideal candidates for CCM training. EM residencies exist as three- (70%) and four-year (30%) training cycles. A unique strength of EM training is that the Accreditation Council for Graduate Medical Education (ACGME) Residency Review Committee (RRC) requires that the trainee receive broad exposure to the undifferentiated critical care patient (see Figure 1).[6] With estimates of a 60% increase in Emergency Department (ED) critical care volume and a reported 1.4 million patients admitted to the ICU through the ED, the EMP staff is a primary portal of entry and provides the most proximal, time-sensitive care for the critically ill and injured.[21] EMPs provide hundreds of patients critical care annually in this country.[5] EM residency also provides a training curriculum with rotations in the ICU (basic RRC requirement of four months) and in-patient floor settings (both medical/surgical). EM residents become adept at multitasking and providing critical care for emergent cardiac failure (STEMI, heart failure, arrhythmias cardiopulmonary failure, etc.), acute neurologic events (stroke, status epilepticus, intracranial hemorrhage, etc.), respiratory failure (hypoxia, COPD, asthma, PNA, etc.), sepsis, toxicology, blunt/penetrating trauma patient, GI hemorrhage, wound care, burn injuries, metabolic derangements, and so on.[6]

Also expected of the EM graduate is procedural acumen with emergent airway stabilization, vascular/arterial access, thoracostomy, para/thora/cardiocentesis, and point-of-care ultrasound imaging, amongst other procedures (see Figure 2).[6]

EMERGENCY MEDICINE AND CRITICAL CARE MEDICINE HISTORY

EM and CCM share multiple common historical threads, having begun around the same time and sharing overlapping developments. Both specialties are concerned with the acute deterioration of the patient. Additionally, the expanding

ED Undifferentiated Critical Care Patient Populations	
Emergent cardiac arrest: STEMI, heart failure, arrhythmias, cardiopulmonary failure, etc.	**Acute neurologic events:** stroke, status epilepticus, intracranial hemorrhage, etc.
Respiratory arrest: hypoxia, COPD, status asthmaticus, PNA, etc.	**Trauma patients:** blunt, penetrating, environmental, burns, traumatic brain injury, etc.
Severe sepsis/Septic shock	Toxicology
GI hemorrhage	Orthopedic emergencies and wound care
Obstetric and Gynecologic emergencies	Metabolic emergencies: DKA, thyroid, adrenal crisis, etc.
Palliative care, EOL	Oncologic emergencies
Understand 24/7 in-house patient care and shift work...	

ACGME Program Requirements for Graduate Medical Education in Emergency Medicine, 2012.

(STEMI: ST-elevation myocardial infarction, COPD: chronic obstructive pulmonary disease, PNA: pneumonia, GI: gastrointestinal, EOL: end-of-life, DKA: diabetic ketoacidosis)

FIGURE 1 Typical Emergency Department (ED) patient population that provides critical care experience for the EM resident.

body of resuscitation research heavily influenced the development of both specialties in the 1960s.[7] EM and CCM are multidisciplinary endeavors whose breadth and depth of knowledge extends across traditional departmental and specialty lines as both deal with organ system derangements in decompensating patients. The following timeline helps to identify some unique intersecting historical points in the U.S. development of both specialties:

- 1968: American College of Emergency Physicians was formed, focusing on emergency and critical care medicine.
- 1970: Society of Critical Care Medicine was formed with a multidisciplinary approach to critical care medicine with the inclusion of EM.
- 1979: American Board of Emergency Medicine (ABEM)formed and emergency medicine becomes the 23rd medical specialty.
- 1979: CCM becomes a subspecialty sponsored by American Board of Internal Medicine (ABIM), American Board of Surgery (ABS), and American Board of Pediatrics (ABP).
- 1986: ABEM applies for co-sponsorship of CCM subspecialty (not approved by ABMS).
- 1989: ABMS approves ABEM as a primary board (removal of conjoint board status).
- 1998: ABEM and ABIM initiate talks to co-sponsor a six-year residency training pathway for triple certification in emergency medicine, internal medicine, and critical care medicine (pathway announced September 1999).
- 2004: White paper on national critical care shortage with potential implications.
- 2004: FOCCUS paper published on framing options for critical care in the United States.
- 2006: White paper published on emergency medicine and critical care medicine certification.
- 2006: Discussion reinitiated between ABEM and ABIM regarding CCM fellowship and certification for EM residency graduates.
- 2011 (September): Institute of Medicine report published a paper on crisis in emergency departments.
- 2011 (September): ABMS approved ABEM and ABIM co-sponsorship of CCM fellowship training pathway leading to the first training and ABMS certification pathway for EM residency graduates.
- 2012 (February): Unilateral sponsorship by ABS for surgical-based critical care fellowship training pathway for EM residency graduates.
- 2013 (July): ABMS approved ABEM and American Board of Anesthesiology (ABA) co-sponsorship of ACCM fellowship training pathway.

Procedural Acumen Required During EM Residency	
Emergent airway stabilization	Vascular/arterial access
Thoracostomy	Point-of-care ultrasound imaging
Para/thora/cardio/ arthrocentesis	Lumbar puncture
Joint manipulation/splinting	Incision & Drainage
Sedation	Advanced wound care
Cardioversion	BLS/ACLS/ATLS (code patients)

ACGME Program Requirements for Graduate Medical Education in Emergency Medicine, 2012.

(BIS: Basic Life Support, ACLS: Advanced Cardiac Life Support, ATLS: Advanced Trauma Life Support)

FIGURE 2 Typical CCM procedures that an EM resident is expected to master during residency.

Canada and parts of Europe recognized the specialty of emergency medicine, along with IM, surgery, anesthesiology, and pediatrics, as acceptable base training programs for CCM eligibility.[7]

Emergency medicine trainees have been pursuing and completing CCM fellowships through various venues since the late 1970s but no formal pathway to United States certification existed for graduates of EM residencies until the 2011 announcement.[4] Lacking access to certification in the United States, many EM/CCM trainees sought formal certification from the European Society of Intensive Care Medicine. Currently, there are over 220 EM/CCM fellowship trained physicians practicing in various models in the United States. The majority of these EM/CCM pioneers practice at major academic centers with prominent clinical and academic roles at the local and national/international level.[8]

EM/CCM PATHWAYS TO CERTIFICATION

MEDICINE

Since September 1999, the American Board of Internal Medicine (ABIM) and American Board of Emergency Medicine (ABEM) have conjointly sponsored an extended residency pathway that allows for potential CCM certification.[9] This

combined residency program, entered through a match out of medical school, is six years in duration and at completion, allows the trainee access to sit for triple board certification in EM, internal medicine (IM), and CCM. Critical care didactic curriculum and clinical training is interspersed during the six-year time frame, with a heavier clinical component of CCM over the final two years of training. Close interaction and cooperation is required between a sponsoring institution's primary residencies of EM and IM to provide adequate didactics and clinical experience. Limitations exist for the number of trainees allowed in this pathway due to potential impact on trainees in the core residencies.[9]

Currently, four programs offer combined EM/IM/CCM training pathways:

- University of Maryland Medical Center
- Henry Ford Hospital Program
- Long Island Jewish Medical Center, Albert Einstein College of Medicine
- Vidant Medical Center/East Carolina University of Medicine

In September 2011, ABMS approved a co-sponsored pathway by ABIM and ABEM to CCM fellowship training and certification after successful completion of an EM residency.[10] Specifics of the ABIM/ABEM CCM pathway include a 24-month curriculum and a prerequisite of completing six months of internal medicine exposure, with a required three months specifically in a dedicated medical intensive care unit (MICU) setting, prior to, or in conjunction with, the start of the fellowship training.[10] The CCM fellowship curriculum requires an additional six months of MICU clinical exposure at the Fellow level, but does allow some latitude with multidisciplinary critical care rotations and further ICU time for the remainder of the two-year training cycle. A stipulation stating that only 25% of trainees can be EM/CCM in a medicine critical care fellowship does create a limit of potential available training slots.[10] The IM-Residency Review Committee also has stipulations in place that exclude EM/CCM graduates who pass the ABIM-CCM certifying exam, the ability to supervise medicine residents in training during their MICU rotations.[11]

The first ACIM-CCM certification exam (through a "practice pathway clause") was offered in 2012. Twenty-five diplomats took this initial certifying exam with all of them successfully obtaining certification.[12] By 2014, a total of 44 EM diplomats have taken the ABIM-CCM certification exam with a 100% pass rate (traditional national first time IM pass rate is 92%).[13] There are currently thirty-four IM-CCM training programs with variability between programs willing to accept EM residency graduates.

SURGERY

In February 2012, the American Board of Surgery (ABS) announced their intention to create access to surgical critical care (SCC) training for EM residents after successful completion of an EM residency.[14] This pathway resulted from an agreement with ABEM and received ABMS approval, without direct co-sponsorship. Specifics of the ABS pathway include completion of 24 months of training, broken into two 12-month blocks that must be completed at the same training institution. The first year (12-month block) requires primary exposure as an advanced preliminary resident to surgical rotations (as determined locally by the Surgery Residency Director and the SCC Fellowship Program Director).[15] During this year, some intermediate-level operative time (i.e., thoracic or abdominal operative cases) must be included to provide exposure to complex surgical conditions.[16] No more than 3 months of time in a surgical intensive care unite (SICU) setting are allowed during this first year of training. The second year (12-month block) is completion of the standard SCC training curriculum. SCC programs wishing to have an EM/CCM training program must submit their proposed first year curriculum to the ABS for approval. No "grandfathering pathway" was offered with the announcement of this critical care certification pathway. The first annual available certification exam was offered in 2015.

ANESTHESIOLOGY

In July 2013, ABMS approved a co-sponsored pathway to critical care medicine certification from the American Board of Anesthesiology (ABA) and ABEM.[17] The ABA/ABEM co-sponsored pathway is unique in its approach to be all-inclusive and to create the potential flexible framework for a well-rounded multidisciplinary clinical-based training curriculum for the EM/CCM fellow.[17] The EM applicant has the prerequisite of needing to complete four months (16 weeks) of ICU rotations during residency (standard RRC requirement for all EM residency graduates) as well as successfully completing an ACGME EM residency. The pathway requires that all EM/CCM fellows complete 24 months of training in an approved ACCM curriculum. This is required of EM applicants, regardless of whether they have completed a 3-year (36-month) or 4-year (48-month) residency program. The 2-year curriculum requires that both years of training be completed at the same ACCM site. During the first 6 months of fellowship training, the EM/CCM fellow should have exposure to at least 3 surgical-based rotations and by completion of the 24-month cycle, the EM/CCM fellow should have completed a total of 12 months of surgical exposure.[18] However, latitude does exist in how to define "surgical exposure." For example, this requirement could be met in a "mixed" Medical/Surgical ICU, or rotations such as nephrology and infectious disease as long as sufficient exposure to surgical patients was gained. The requirements also encourage multidisciplinary critical care exposure to rotations such as pulmonary medicine, bronchoscopy, cardiology, neurologic disorders, as well as anesthesiology rotations (pre-op or peri-operative rotations). This pathway is a clinical-based curriculum and requirements do stress that no more than two elective rotations (2 months) can be spent pursuing research.[18]

ACCM programs must apply for formal EM/CCM two-year curriculum approval through the ABA.[18] A limited