Critical Care Pharmacy: Past and Present

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Learning Objectives

1. Describe key landmark events in the evolution of critical care pharmacy as a specialty.
2. Summarize key published documents and evidence validating critical care pharmacy as a specialty for validation to other health care professionals and stakeholders.
3. Outline the major critical care pharmacist activities within the three levels of clinical services (i.e., fundamental, desirable, and optimal), as defined by SCCM and the ACCP Task Force on Critical Care Pharmacist Services in 2000.
4. Summarize the findings from key studies documenting the association of critical care pharmacy services with favorable health care outcomes.
5. List the criteria for credentialing and training of pharmacists providing critical care services at the desired and optimal levels as outlined in the 2011 ACCP Critical Care PRN opinion paper in addition to critical care training opportunities and growth.
6. List the core knowledge areas for pharmacists caring for critically ill patients.

Abbreviations in this Chapter

ACCM	American College of Critical Care Medicine
ACCP	American College of Clinical Pharmacy
ACLS	Advanced cardiac life support certification
ASHP	American Society of Health-System Pharmacists
BPS	Board of Pharmacy Specialties
ICU	Intensive care unit
SCCM	Society of Critical Care Medicine

Self-Assessment Questions

Answers and explanations to these questions may be found at the end of the chapter.

1. Which best represents the journal that was first to publish a critical care therapeutics column in 1982?
   A. *Drug Intelligence and Clinical Pharmacy.*
   B. *Pharmacotherapy.*
   C. *Chest.*
   D. *Heart and Lung.*

2. The scope of pharmacy practice within the intensive care unit (ICU) was outlined by two task forces focused on models of critical care delivery, the definition of an intensivist, and the practice of critical care medicine within three different proposed models in 2001. Which best shows the organization that formed these two task forces?
   A. Institute of Medicine.
   B. American College of Clinical Pharmacy (ACCP).
   C. American College of Critical Care Medicine (ACCM).
   D. Clinical pharmacy and pharmacology section of the Society of Critical Care Medicine (SCCM).

3. Which most accurately describes a service listed uniquely within the "optimal" level of critical care pharmacy services according to the "Position Paper on Critical Pharmacy Services" published in 2000?
   A. Securement of funds for clinical research studies.
   B. Response to resuscitation events.
   C. Pharmacokinetic monitoring.
   D. Publication of critical care case reports.

4. Which best depicts the medical event for which a higher mortality in ICUs without clinical pharmacists compared with ICUs with clinical pharmacists been documented?
   A. Corrected QT (QTc)-interval prolongation.
   B. Preventable adverse drug interactions.
   C. Drug-drug interactions.
   D. Nosocomial-acquired infections.

5. Which best describes what is deemed a core knowledge base area for pharmacists caring for critically ill patients?
   A. Infectious diseases.
   B. Oncology.
   C. Transplantation.
   D. Obstetrics.

6. Which most accurately reflects the journal that published a landmark study documenting a decrease in preventable adverse drug reactions after the inclusion of pharmacists on interdisciplinary medical rounds?

   A. *New England Journal of Medicine*.
   B. *Lancet*.
   C. *Journal of the American Medical Association*.
   D. *Annals of Internal Medicine*.

7. According to the 2011 ACCP Critical Care Practice and Research Network (PRN) opinion paper, which best describes the credentialing criterion that is included uniquely under "optimal" credentialing for pharmacists providing critical care pharmacy services?

   A. Critical care fellowship training.
   B. Board of Pharmacy Specialties (BPS) certification.
   C. Advanced cardiac life support certification (ACLS).
   D. Postgraduate year two (PGY2) training in critical care.

8. There were eight American Society of Health-System Pharmacists (ASHP)-accredited critical care pharmacy residencies in 2001. Assuming linear growth, which most accurately represents the approximate yearly increase in ASHP-accredited critical residencies between 2001 and 2014?

   A. 6.
   B. 8.
   C. 10.
   D. 12.

I. LANDMARK EVENTS IN CRITICAL CARE MEDICINE/PHARMACY

A. First Intensive Care Unit (ICU): Three-Bed Neurosurgical Unit in Baltimore, Maryland (1930s)

B. First Pharmacists Assigned to ICUs in a Limited Number of Hospitals – Occurred in the late 1960s

C. Several Critical Care Pharmacists ICU Practices Established (in or around the 1970s; clinical research conducted in a wide array of therapeutic specialty areas [e.g., pharmacokinetics, infectious diseases, nutrition support, ACLS])
   1. Cardiovascular ICUs
   2. Pediatric/neonatal ICUs
   3. Medical ICUs
   4. Emergency medicine
   5. Trauma
   6. Surgical ICUs
   7. Neurosurgical ICUs

D. Formation of SCCM with 100 Members (1970)
   1. Multidisciplinary model stressed by founding SCCM President Max Harry, M.D.
   2. Subsequent inclusion of pharmacists as a permanent member of the SCCM governing council

E. Emergence of Critical Care Specialty Journals and Publications
   1. *Heart and Lung* (1972)
   2. *Intensive Care Medicine* (1972)
   3. *Critical Care Medicine* (1973)
   4. *Critical Care Clinics* (1984)
      a. Critical care therapeutics column in *Drug Intelligence and Clinical Pharmacy* (1982)
      b. First critical care pharmacy textbook: *Critical Care Pharmacy* (1985)

F. Formation of Critical Care Pharmacists Specialty Groups
   1. SCCM clinical pharmacy and pharmacology section (1989)
   2. ACCP Critical Care PRN (1992)

II. VALIDATION OF CRITICAL CARE PHARMACY AS A SPECIALTY

A. Chapter Titled "The Role of the Pharmacist in Caring for the Critically Ill Patient," Published in *The Pharmacologic Approach to the Critically Ill Patient*, 3rd ed. (1994)

B. Publication of "Position Paper on Critical Care Pharmacy Services" (Crit Care Med 2000); establishment of three levels of pharmacy services (fundamental, desirable, optimal) for the provision of pharmaceutical care in critically ill patients (see specifics that follow)

C. SCCM Recognition of Critical Care Pharmacists as an Integral Member of the Multidisciplinary Team Together with Physicians, Nurses and Respiratory Therapists (Crit Care Med 2001)

D. Scope of Pharmacy Practice Within ICU Outlined by Two ACCM Task Forces: Models of critical care delivery and definition of an intensivist and the practice of critical care medicine within three different proposed models (critical care pharmacy and pharmacist services deemed "essential" within level 1 critical care centers as endorsed by ACCM (Crit Care Med 2003;31:2677-83)

E. Awarding of FCCP Status by ACCM: More than 70 pharmacists for an overall total of 908; six MCCMs (Master Critical Care Medicine) (2014)

F. Receipt of Several Honor and Awards by Critical Care Pharmacists Within SCCM, ACCM, and ACCP
   1. SCCM/ACCM: Distinguished Investigator Award, Shubin-Weil Master Clinician, Excellence in Bedside Teaching Award, Distinguished Service Award
   2. ACCP: Russell R. Miller Award, Paul F. Parker Medal, Clinical Practice Award, Robert M. Elenbaas Service Award, Education Award
   3. Creation of the Joseph F. Dasta Critical Care Pharmacy Outcomes Research Grant by the clinical pharmacy and pharmacology section of SCCM (2000)

G. Leadership Roles in Major Multidisciplinary and Pharmacy Organizations
   1. SCCM: President Judi Jacobi (2010)
   2. ACCP: Presidents Robert Elenbaas, Barbara Zarowitz, Bradley Boucher, Curtis Haas, Judi Jacobi

H. Prescriber Perceptions of Pharmacist-Provided Patient Care–Related Clinical Functions: Decreased efficiencies between 40% and 65% in the absence of pharmacy services (Pharmacotherapy 2013;33:401-10).

III. CRITICAL CARE PHARMACY GROWTH

A. SCCM Membership: ~15,900, CPP Membership ~2180 (13.7)%

B. Provision of Direct Patient Care Services: 62.2% of ICUs responding to hospital survey (Ann Pharmacother 2006;40:612-8)

IV. STUDIES DOCUMENTING THE ASSOCIATION OF CRITICAL CARE PHARMACY SERVICES WITH FAVORABLE HEALTH CARE OUTCOMES

A. Reduction in Drug Costs in ICU with the Inclusion of a Pharmacist as a Member of the Multidisciplinary Team
   1. Medical-surgical ICU: Annual savings of $67,664 in 1994 dollars (Crit Care Med 1994;22:1044-8)
   2. Neurosurgical ICU: Reduction in pharmacy acquisition costs from $4833 to $3239/patient after the addition to a pharmacist to the neurosurgery team; reduction in ICU days from 8.56 to 7.24 days ($p=0.003$) (Neurosurgery 2009;65:946-50; discussion 950-1)
   3. Several other studies in a wide range of ICU settings (see Intensive Care Med 2003;29:691-8)

B. Reduction in Adverse Drug Effects/Drug-Drug Interactions
   1. Decrease in preventable adverse drug effects after the inclusion of a pharmacist on interdisciplinary medical ICU rounds: 66%, $p<0.001$ (JAMA 1999;282:267-70)
   2. Decreased incidence of QTc-interval prolongation with ICU monitoring by a pharmacist using a standard algorithm: 19% versus 39% ($p=0.006$) (Ann Pharmacother 2008;42:475-82)

3. Reduction in drug-drug interactions by 65% ($p<0.01$) in medical ICUs with a pharmacist (J Crit Care 2011;26:104.e101-106)

C. Improvement in Infectious Diseases Morbidity, Mortality, and Costs (Crit Care Med 2008;36:3184-9).
   1. Mortality higher in ICUs without clinical pharmacists compared with ICUs with clinical pharmacists: 23.6% for nosocomial-acquired infections, 16.2% for community-acquired infections, 4.8% for sepsis ($p\leq0.008$)
   2. Length of stay longer for ICUs without clinical pharmacists compared with ICUs with clinical pharmacists: 7.9% for nosocomial-acquired infections, 5.9% for community-acquired infections, 8.1% for sepsis ($p\leq0.03$)
   3. Medicare bills increased the number of patients in ICUs without clinical pharmacists compared with ICUs with clinical pharmacists: 12% for nosocomial-acquired infections, 11.9% for community-acquired infections, 12.9% for sepsis ($p<0.001$)

D. Improvement in Thromboembolic and Infarction-Related Event (TIE) Clinical and Economic Outcomes (Pharmacotherapy 2009;29:761-8)
   1. Mortality increased in ICU patients with TIE without clinical pharmacy services compared with ICU patients with clinical pharmacy services: 37%, $p<0.0001$.
   2. Bleeding complications increased by 49% ($p<0.001$), with 39% more patients receiving transfusions ($p<0.001$) in ICUs without clinical pharmacy services.
   3. Length of ICU stay and costs were significantly higher in patients with TIE in ICUs without clinical pharmacy services.

E. Impact of ICU Protocols on Patient Outcome
   1. Significant improvement in sedation and analgesia monitoring targets with the use of protocol versus empiric therapy ($p\leq0.01$); no difference in length of ICU stay (Pharmacotherapy 2000;20:662-72)
   2. Pharmacist-enforced ICU sedation protocol reduced mechanical ventilator duration as well as ICU, hospital length of stay ($p<0.001$) (Crit Care Med 2008;36:427-33)

V. MAJOR PHARMACY SERVICE ACTIVITY CATEGORIES FOR CRITICAL CARE PHARMACISTS

A. Clinical

B. Educational

C. Scholarly

D. Administrative (e.g., business models, policy development)

VI. LEVELS OF CRITICAL CARE PHARMACIST SERVICES (SCCM/ACCP TASK FORCE RECOMMENDATIONS, 2000)

A. Fundamental: Services that must be provided for the safe delivery of pharmaceutical care to critically ill patient populations
   1. Predominant commitment of time to critically ill patients
   2. Prospective evaluation of all drug therapy for safety and efficacy, with intervention as needed

3. Evaluation of parenteral nutrition orders
4. Identification of adverse drug events
5. Pharmacokinetic monitoring
6. Provision of drug information and intravenous drug compatibility data
7. Provision of informal drug therapy–related education to ICU team members
8. Documentation of clinical activities
9. Implementation and maintenance of policies and procedures related to safe and effective drug use in the ICU
10. Service on ICU and hospital committees

B. Desired: Additional services and clinical functions for the specialized care of critically ill patients
1. Rounds as a member of an interdisciplinary critical care team
2. Conducts medication histories and evaluates need for continuance of therapy
3. Provides formal nutrition consultations
4. Responds to resuscitation events
5. Provides didactic lectures to health professional students and postdoctoral trainees
6. Trains student pharmacists, residents, and fellows through experiential education
7. Coordinates the development and implementation of drug therapy protocols and critical care pathways
8. Provides advanced documentation of services to include the clinical significance and economic value of interventions
9. Actively engages in critical care pharmacotherapy research, including screening and enrollment of prospective study patients, study coordination, research study design, and data analysis
10. Disseminates case reports and practice insights to other practitioners by publication within the pharmacy and medical literature

C. Optimal: Integrated, specialized, and dedicated model of patient care aimed at optimizing patient outcomes
1. Assists physicians with patients and/or family members to make informed decisions regarding treatment options
2. Provides formal accredited educational sessions for medical staff, students, and residents
3. Teaches ACLS
4. Develops and coordinates critical care pharmacy residencies and/or fellowships
5. Develops pharmacist and technician training programs for personnel working in the ICU
6. Is proactively involved in designing, prioritizing, and promoting new pharmacy program and services
7. Secures funds for clinical research studies through investigator-initiated grants and contracts
8. Publishes peer-reviewed reports in the pharmacy and medical literature of original critical care clinical research, outcome and administrative research, or laboratory analyses

VII. CRITICAL CARE PHARMACIST TRAINING AND CREDENTIALING

A. First Critical Care Pharmacy Residency Described: 1981 (The Ohio State University)

B. ASHP Critical Care Pharmacy Residency Standards Published in 1990

C. 116 ASHP-Accredited Critical Care Residencies in 2014; increased from 8 in 2001 and from 39 in 2005. (Note: 67,357 adult ICU beds in the United States as of 2009)

D. Most PGY2 Critical Residents Somewhat or Very Satisfied (91% and 76%, respectively) with Their Program and Mentorship According to 2012 Survey

E. ACCP Critical Care PRN Opinion Paper: Recommendations for "desirable" credentialing of pharmacists providing critical care services include pharmacy degree, active state licensure, postgraduate year one (PGY1) residency, BPS certification, and ACLS certification; "optimal" credentialing: all of the above criteria in addition to PGY2 training in critical care (or related practice area (e.g., emergency medicine, transplantation)

F. Critical Care Pharmacists Have Traditionally Sought Credentialing Through Board Certification in Pharmacotherapy or Nutrition Support

G. Critical Care Pharmacy Research Training: Long history of fellowship training

H. ASHP Research and Education Foundation Critical Care Traineeships

I. SCCM Clinical Pharmacy and Pharmacology Section Mentoring Services: Practice, education, administration, scholarship

J. Implications of New ACCP Clinical Pharmacy Standards on Critical Care Pharmacy Specialty

VIII. CORE KNOWLEDGE BASE AREAS FOR PHARMACISTS CARING FOR CRITICALLY ILL PATIENTS (2012 BPS CRITICAL CARE CONTENT OUTLINE)

A. Pulmonary

B. Cardiovascular

C. Neurology and Neurologic Injuries

D. Psychiatry

E. Renal

F. Hepatogastrointestinal

G. Immunology

H. Endocrine

I. Hematology

J. Infectious Diseases

K. Toxicology

L. Surgery

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ANSWERS AND EXPLANATIONS TO SELF-ASSESSMENT QUESTIONS

1. Answer: A

The journal *Drug Intelligence and Clinical Pharmacy* (now *Annals of Pharmacotherapy*) was the first to publish a critical care therapeutics column in 1982, which was a landmark event relative to the evolution of critical care pharmacy. Although the other journals listed, *Pharmacotherapy* (Answer B), *Chest* (Answer C), and *Heart and Lung* (Answer D), publish critical care therapeutics articles, *Annals of Pharmacotherapy* was the first to incorporate a critical care therapeutics column into its publication.

2. Answer: C

The ACCM, which exists within the organizational framework of the SCCM, formed the two task forces focused on models of critical care delivery, the definition of an intensivist, and the practice of critical care medicine within three different proposed models in 2001 (Answer C). The Institute of Medicine (Answer A) and ACCP (Answer B) were not involved in formulating the levels of critical care delivery. Although the clinical pharmacy and pharmacology section of SCCM (Answer D) may have contributed to this document, there is no mention of the clinical pharmacy and pharmacology section in the publication.

3. Answer: A

The securement of funds for clinical research studies is listed for the first time under the "optimal" level of critical care pharmacy services. Therefore, Answer A is correct. Responding to resuscitation events (Answer B) and publication of critical care case reports (Answer D) are listed under the "desired" level of critical care pharmacy services and are incorrect. Pharmacokinetic monitoring (Answer C) is a "fundamental" critical care pharmacy services and is therefore incorrect.

4. Answer: D

In a 2008 study, mortality rates were higher in ICUs without clinical pharmacists compared with ICUs with clinical pharmacists: 23.6% for nosocomial-acquired infections, 16.2% for community-acquired infections, and 4.8% for sepsis ($p \leq 0.008$). Although the impact of clinical pharmacists in affecting QTc-interval prolongation (Answer A), preventable adverse drug interactions (Answer B), and drug-drug interactions (Answer C) has been evaluated, differences in mortality have not been documented. Therefore, these answers are incorrect.

5. Answer: A

The core knowledge areas for pharmacists caring for critically ill patients include pulmonary, cardiovascular, neurology and neurologic injuries, psychiatry, renal, hepatogastrointestinal, immunology, endocrine, hematology, infectious diseases, toxicology, and surgery. Therefore, infectious diseases (Answer A) is correct. Oncology (Answer B), transplantation (Answer C), and obstetrics (Answer D) are not considered core knowledge areas and are therefore incorrect.

6. Answer: C

The landmark study documenting a decrease in preventable adverse drug reactions after the inclusion of pharmacists on interdisciplinary medical rounds was published in the *Journal of the American Medical Association* by Dr. Lucian Leape and colleagues (Answer C). This highly publicized article published in a mainstream medical journal by a physician remains one of the foundational studies documenting the association of critical care pharmacy services with favorable health care outcomes. The other mainstream medical journals, *New England Journal of Medicine* (Answer A), *Lancet* (Answer B), and *Annals of Internal Medicine* (Answer D), have not published similar articles on preventable adverse drug reactions after the inclusion of pharmacists on interdisciplinary medical rounds.

7. Answer: D

The 2011 ACCP Critical Care PRN opinion paper outlining recommendations for "desirable" credentialing of pharmacists providing critical care services, includes pharmacy degree, active state licensure, PGY1 residency, BPS certification, and ACLS certification; "optimal" credentialing includes all of the above criteria in addition to PGY2 training in critical care or a related practice area (e.g., emergency medicine, transplantation). Therefore, PGY2 training in critical care (Answer D) is correct. Board of Pharmacy Specialties certification (Answer B) and ACLS certification (Answer C) are in both the

desirable and optimal credential categories and are therefore incorrect. Critical care fellowship training (Answer A) is not included in either the desired or the optimal categories and thus is incorrect.

8. Answer: B

As stated, there were eight ASHP-accredited critical care pharmacy residencies in 2001. In 2014, ASHP notes 116 ASHP-accredited critical care pharmacy residencies. Assuming linear growth, the 108-residency increase over 13 years equals an increase of about eight residencies per year. Therefore, Answer B is correct. Although this represents significant growth, more than 2200 pharmacists would be needed to provide critical care pharmacy services, assuming 30 patients/pharmacists in the more than 67,000 adult ICU beds in the United States as of 2009. Answer A (6 residencies/year), Answer C (10 residencies/year), and Answer D (12 residencies/year) are incorrect.