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JOSEPH L. NATES
KRISTEN J. PRICE
EDITORS

Oncologic Critical Care

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Joseph L. Nates • Kristen J. Price
Editors

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With 225 Figures and 278 Tables

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We dedicate this book to our families
for their patience and understanding during the long hours of work away from them
We hope that this pioneering work leads
to improvements in the care of the critically ill cancer patients around the world

Preface

The Growing Need for Organized Oncologic Critical Care Services

The world population continues its inexorable growth. Based on the United Nations' latest report on world population, we have reached a population of 7.5 billion people of which 1 billion are over 60 years of age. Currently, there are more than 549 million people over the age of 60 in Asia, practically doubling today's US population. This trend has been named the "silver tsunami" and its social and healthcare impact worldwide is of great concern. As the population rises, so does the number of new cancer cases a year. For the past two decades, cancer has been the second cause of death for all ages in most of the world. In 2012, the World Cancer Research Fund and the American Institute for Cancer Research estimated that there were more than 14 million new cases of cancer and 8.2 million related deaths. In 2018, the age-standardized rate for all cancers was 197.9 per 100,000 habitants. By 2030, the global burden of the disease is expected to reach 21.7 million new cases and 13 million deaths per year.

As the burden of cancer rises, the needs for supportive and critical care healthcare services expand. Unfortunately, multiple factors are at work against a timely and proportionate response from the critical care world. First, the supply and demand for critical care services is growing apart. The timely Committee on Manpower for Pulmonary and Critical Care Societies (COMPACCS) report of the distribution of critical care services in the USA clearly showed clearly this threat. Second, as the currently trained personnel age, they retire and increase the growing deficit. Third, the need for critical care services increases as we get older, ranging from less than 1 specialist per 100,000 habitants at 44 years of age or younger to more than 9 specialists per 100,000 habitants when we reach 84 years of age or older. Fourth, the sharp increase in healthcare costs has overloaded national budgets. The high cost of numerous new technologies, drugs, and the inefficiency of most services are in part to blame. Even the organ-based approach, where among others, all heart, lung, and brain problems are managed by the cardiologist, pulmonologist, and neurologist/neurosurgeon, respectively, contributes to the problem. Unfortunately, there are so many other factors that continue compounding the above challenges that we cannot discuss them all. However, perhaps the greatest of all is that oncologic critical care does not exist as such.

For decades, critically ill onco-hematologic patients have been denied admission to intensive care units around the world with the excuse of poor predicted outcomes. Most critical care organizations have not acknowledged this lack of access, do not have an oncologic section, and allocate minimal space for lectures in their congresses about the specific problems only seen in these populations. Specialty colleges do not recognize this as a subspecialty or dedicate a significant portion of their training to it.

There is an urgent need to develop a robust and organized response from our specialty. This textbook, the first of its class, and our international efforts in education and research are part of this response. As the frontline leaders and pioneers of this new field, namely *Oncologic Critical Care*, I appeal to all of you to join us in the prevention and fight against cancer-related critical illnesses.

Founding President of the
Oncologic Critical Care Research Network
October 2019

Joseph L. Nates

Introduction

Oncologic Critical Care: The Birth of a New Subspecialty

The field of Critical Care has grown rapidly since its beginning in the 1950s. With the increasing proportion of persons above 65 years of age with a 50% overall risk of developing cancer during their lifetimes, cancer rates continue to play a role in the utilization of healthcare services–particularly in the intensive care unit (ICU). This, coupled with a shortage of critical care providers in the next two decades, makes identifying the outcomes of the available oncologic critical care resources imperative.

Currently, no oncologic journals, subspecialty societies in the field, or adequate understanding about the current availability of oncologic/hematologic ICUs exist. Except for our publication in Spanish, no other comprehensive textbooks in oncologic critical care are available. As such, there are major knowledge gaps about outcomes (e.g., ICU utilization, mortality, costs), healthcare disparities (e.g., racial, geographic), and almost all aspects of intensive care delivery to the critically ill cancer patient.

This book, by serving as the first comprehensive source in Oncologic Critical Care, seeks to close these knowledge gaps and serve as a vehicle of education for the current and successive generations of healthcare providers dedicated to the practice of Oncologic Critical Care. The book's target audience encompasses intensivists, medical oncologists, surgical oncologists, general physicians, hospitalists, advance practice providers, nurses, fellows, residents, medical students, and other healthcare providers that take care of cancer patients. This work is a collaborative effort among international experts aimed at specifically focusing on challenges encountered in the diagnosis and management of the critically ill cancer patient population.

This novel resource has 19 parts with over 140 chapters and more than 2,000 pages of care focused on the management of the critically ill cancer patient. It covers all aspects of what we consider a new subspecialty, *Oncologic Critical Care*, that are scarcely covered in standard critical care books. The included chapters explore the following topics in oncologic critical care: organization and management of an oncologic critical care unit, multidisciplinary care and the integration of advance practice providers in this environment, all aspects of clinical pharmacy, and dermatologic complications, and also neurologic, respiratory, cardiovascular, gastrointestinal, genitourinary, renal, and hematological diseases. In addition, we discuss

metabolic/endocrine and vascular complications, transfusion medicine practices, infectious diseases, perioperative care of the critically ill cancer patient, care of special populations, critical care procedures and their challenges in coagulopathic patients, ethics, pain management, palliative care, and outcomes.

Finally, we hope you enjoy and take full advantage of this amazing resource!

Joseph L. Nates
Kristen J. Price

Acknowledgments

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Contents

Volume 1

Part I Organization and Management of an Oncologic Critical Care Unit 1

1 Oncologic Critical Care Department Organization 3
Kristen J. Price

2 ICU Utilization 11
Karen Chen, Susannah K. Wallace, and Joseph L. Nates

3 Critical Care Admissions and Discharge Criteria in Cancer Patients 19
Ignacio Pujol Varela and Isidro Prieto del Portillo

4 ICU Staffing, Models, and Outcomes 33
Karen Chen and Joseph L. Nates

5 Multidisciplinary Care of Critically Ill Cancer Patients 43
Ninotchka Brydges, Brandi McCall, and Tiffany Mundie

6 Advanced Practice Providers in the Oncologic Intensive Care Unit 65
Ninotchka Brydges, Tiffany Mundie, and Garry Brydges

7 Early Warning Systems and Oncological Critical Care Units 75
Michelle O'Mahony and Tim Wigmore

8 Rapid Response Team (RRT) in Critical Care 87
Ninotchka Brydges and Tiffany Mundie

9 Quality Assurance and Improvement in the Intensive Care Unit 95
Mary Lou Warren

10 Patient Risk Prediction Model 107
Michelle O'Mahony and Tim Wigmore

11 Outcomes in Critically Ill Oncologic Patients 121
Silvio A. Ñamendys-Silva

Part II Pharmacologic Considerations for the ICU Cancer Patient **127**

12 Role of the Clinical Pharmacist in the Oncologic Intensive Care Unit 129
Brian M. Dee

13 Stress Ulcer Prophylaxis in the Critically Ill Oncology Population 137
Reagan D. Collins

14 Antimicrobial Prophylaxis in High-Risk Oncology Patients 153
Jeffrey J. Bruno and Frank P. Tverdek

15 Considerations for Medications Commonly Utilized in the Oncology Population in the Intensive Care Unit 169
Anne Rain Tanner Brown, Michelle Horng, and Terri Lynn Shigle

16 Complications and Toxicities Associated with Cancer Therapies in the Intensive Care Unit 201
Melvin J. Rivera, Bryan Do, Jeffrey C. Bryan, Terri Lynn Shigle, and Rina Patel

17 Supportive Care Considerations and Nutrition Support for Critically Ill Cancer Patients 229
Anne M. Tucker, Jacob W. Hall, Christine A. Mowatt-Larssen, and Todd W. Canada

Part III Dermatologic Complications **247**

18 Graft Versus Host Disease (GHVD) in Critically Ill Oncologic Patients 249
Ulas Darda Bayraktar

19 Stevens–Johnson Syndrome (SJS) and Toxic Epidermal Necrolysis (TEN) 267
Danielle Zimmerman and Nam Hoang Dang

20 Mycosis Fungoides in Critically Ill Cancer Patients 281
Brian H. Ramnaraign and Nam Hoang Dang

Part IV Neurologic Diseases **297**

21 Delirium and Psychosis in Critically Ill Cancer Patients . . . 299
Kimberly F. Rengel, Daniel A. Nahrwold, Pratik P. Pandharipande, and Christopher G. Hughes

22 Medication-Induced Neurotoxicity in Critically Ill Cancer Patients 319
Monica E. Loghin and Anne Kleiman

23 **Seizures and Status Epilepticus in Critically Ill Cancer Patients** 335
Vishank A. Shah and Jose I. Suarez

24 **Posterior Reversible Encephalopathy Syndrome (PRES) in Cancer Patients** 353
Bryan Bonder and Marcos de Lima

25 **Stroke in Critically Ill Cancer Patients** 367
Ritvij Bowry and James C. Grotta

26 **Intracranial Hemorrhage Focused on Cancer and Hemato-oncologic Patients** 381
Yasser Mohamad Khorchid and Marc Malkoff

27 **Increased Intracranial Pressure in Critically Ill Cancer Patients** 395
Abhi Pandhi, Rashi Krishnan, Nitin Goyal, and Marc Malkoff

28 **Leptomeningeal Disease in Solid Cancers** 409
Nazanin K. Majd and Monica E. Loghin

29 **Metastatic Spinal Cord Compression** 429
John W. Crommett

30 **Frequent Central Nervous System (CNS) Infections in the Immunosuppressed Patient** 435
Rafael Araos and Grecia Aldana

Part V Respiratory Diseases **443**

31 **Acute and Chronic Respiratory Failure in Cancer Patients** 445
Steven P. Sears, Gordon Carr, and Christian Bime

32 **Noninvasive Oxygen Therapies in Oncologic Patients** 477
Michael C. Sklar, Bruno L. Ferreyro, and Laveena Munshi

33 **Respiratory Support Strategies and Nonconventional Ventilation Modes in Oncologic Critical Care** 499
Yenny R. Cardenas and Joseph L. Nates

34 **Prone Ventilatory Therapy in Critically Ill Cancer Patients** 509
Alex Pearce and Rebecca E. Sell

35 **Extracorporeal Membrane Oxygenation (ECMO) Critically Ill Cancer Patients** 517
Thomas Staudinger, Peter Schellongowski, and Philipp Wohlfarth

36 **Cancer Treatment-Related Lung Injury** 531
Vickie R. Shannon

37 Acute Respiratory Distress Syndrome in Cancer Patients 557
Alisha Y. Young and Vickie R. Shannon

38 Diffuse Alveolar Hemorrhage in Critically Ill Cancer Patients 583
Brian W. Stephenson, Allen H. Roberts II, and Charles A. Read

39 Differentiation (Retinoic Acid) Syndrome in Critically Ill Cancer Patients 593
Cristina Prata Amendola, Ricardo André Sales Pereira Guedes, and Luciana Coelho Sanches

40 Pneumonia in the Cancer Patient 607
Ala Eddin S. Sagar and Scott E. Evans

41 Late Noninfectious Pulmonary Complications in Hematopoietic Stem Cell Transplantation 625
Kevin Dsouza, Cameron Pywell, and Victor J. Thannickal

42 Pleural Disease: Malignant and Benign Pleural Effusions 643
María F. Landaeta and Macarena R. Vial

43 Management of Tracheobronchial Diseases in Critically Ill Cancer Patients 653
Donald R. Lazarus and George A. Eapen

44 Tracheostomy 667
Macarena R. Vial and Joseph L. Nates

45 Pulmonary Hypertension in an Oncologic Intensive Care Unit 675
Lilit A. Sargsyan and Saadia A. Faiz

46 Sleep Disorders in Critically Ill Cancer Patients 699
Matthew Scharf, Niki Kasinathan, and Jag Sunderram

Volume 2

Part VI Cardiovascular Diseases 709

47 Acute Coronary Syndrome, Thrombocytopenia, and Antiplatelet Therapy in Critically Ill Cancer Patients 711
Teodora Donisan, Dinu Valentin Balanescu, Gloria Iliescu, Konstantinos Marmagkiolis, and Cezar Iliescu

48 Arrhythmias in Cancer Patients 733
Peter Kim, Abdulrazzak Zarifa, Mohammed Salih, and Kaveh Karimzad

49 Hemodynamic Evaluation and Echocardiography in the Oncologic Intensive Care Unit 753
Raymundo A. Quintana, Nicolas Palaskas, and Jose Banchs

50 Hemodynamic Evaluation and Minimally Invasive Hemodynamic Monitoring in Critically Ill Cancer Patients 775
Phornlert Chatrkaw and Kanya Kumwilaisak

51 Interventional Cardiology in the Cancer Patient 787
Dinu Valentin Balanescu, Teodora Donisan, Konstantinos Marmagkiolis, and Cezar Iliescu

52 Management of Pericardial Effusions/Tamponade in Cancer Patients 807
Sana Shoukat and Syed Wamique Yusuf

53 Chemotherapy-Related Cardiovascular Complications 815
Muzna Hussain and Patrick Collier

54 Outcomes After Cardiopulmonary Resuscitation in the Cancer Patient 837
Cristina Gutierrez

Part VII Gastrointestinal Disease **845**

55 Acute Abdomen in Cancer Patients 847
Celia Robinson Ledet and David Santos

56 Gastrointestinal Bleeding in Critically Ill Cancer Patients 857
David M. Richards and William A. Ross

57 Endoscopic and Pharmacologic Management of Upper GI Bleeding 869
David M. Richards, Sajini Thekkel, and William A. Ross

58 Malignant Ascites in Critically Ill Cancer Patients 885
Cristina Prata Amendola, Luís Gustavo Capochin Romagnolo, and Raphael L. C. Araujo

59 Hepatobiliary Diseases in the Cancer Patient Leading to Critical Illness 893
Faisal S. Ali, Hamzah Abu-Sbeih, Emmanuel Coronel, and Yinghong Wang

Part VIII Renal and Genitourinary Disease **919**

60 Acute Renal Failure in Critically Ill Cancer Patients 921
Aisha Khattak and Kevin W. Finkel

61 Renal Replacement Therapy in Critically Ill Cancer Patients 937
Kevin W. Finkel and Jaya Kala

62 Hematuria in the Critically Ill Cancer Patients 949
Chukwuma O. Kalu and Ala Abudayyeh

63 Hemorrhagic Cystitis in the Critically Ill Cancer Patient ... 959
Chukwuma O. Kalu and Ala Abudayyeh

64 Obstructive Uropathy in Critically Ill Cancer Patients 969
Chukwuma O. Kalu and Ala Abudayyeh

Part IX Metabolic/Endocrine Complications **977**

65 Adrenal Emergencies in Critically Ill Cancer Patients 979
Ryan P. Richard, Julie A. Grishaw, and Kyle B. Enfield

66 Carcinoid Crisis in the Intensive Care Unit 995
Ozge Keskin and Suayib Yalcin

67 Thyroid Emergencies in Critically Ill Cancer Patients 1003
Sarimar Agosto and Sonali Thosani

68 Electrolytic Abnormalities Related to Calcium in Critically Ill Cancer Patients 1017
Agamenón Quintero, Jorge Racedo, and Manuel González Fernández

69 Electrolytic Abnormalities Related to Phosphate in Critically Ill Cancer Patients 1029
Agamenón Quintero, Jorge Racedo, and Roger de Jesús Durante Flórez

70 Electrolytic Abnormalities Related to Sodium in Critically Ill Cancer Patients 1041
Agamenón Quintero, Jorge Racedo, Carlos Andrés Pérez Acosta, and Sandra Aruachán

71 Electrolytic Abnormalities Related to Potassium in Critically Ill Cancer Patients 1053
Agamenón Quintero, Jorge Racedo, and Aaron Rafael Quintero Hernández

72 Electrolytic Abnormalities Related to Magnesium in Critically Ill Cancer Patients 1067
Agamenón Quintero, Jorge Racedo, and Heinznel Negrete

73 Hypoglycemia and Hyperglycemia in Critically Ill Cancer Patients 1079
Seda Hanife Oguz, Ugur Unluturk, Sahin Lacin, Alper Gurlek, and Suayib Yalcin

Part X Hematologic Diseases **1093**

74 Benign Hematological Diseases in Cancer Patients 1095
Kelly N. Casteel and Michael H. Kroll

75 Thrombotic Thrombocytopenic Purpura and Hemolytic Uremic Syndrome in Cancer Patients 1109
Peter J. Miller

76 Tumor Lysis Syndrome in the Cancer Patient 1119
O'Dene Lewis and Stephen M. Pastores

77 Blast Crisis of Chronic Myeloid Leukemia (CML) 1135
Rita Assi and Nicholas Short

78 Hyperleukocytosis in Cancer Patients 1147
Lohith Gowda and Chitra Hosing

79 Hemophagocytic Lymphohistiocytosis in the Cancer Patient 1155
Olakunle Idowu, Jeanneé Campbell, and Naval Daver

Part XI Transfusion Medicine **1163**

80 Statistics in Blood Collection and Transfusion 1165
Fernando Martinez

81 Blood Components 1171
Fernando Martinez and Faysal Fedda

82 Transfusion Reactions 1177
Adriana Maria Knopfelmacher

83 Transfusion-Related Acute Lung Injury (TRALI) 1191
Adriana Maria Knopfelmacher

84 Alternatives to Blood Products 1197
James M. Kelley

85 Massive Transfusion Protocols (MTPs) in Cancer Patients 1205
Adriana Maria Knopfelmacher and Fernando Martinez

86 Guidelines for Blood Transfusion in Patients 1213
Fernando Martinez

Part XII Vascular Complications **1221**

87 Management of Arterial Bleeding in Critically Ill Cancer Patients 1223
T. T. T. Huynh and R. A. Sheth

88 Prevention and Management of Venous Thromboembolism in the Cancer Patient 1243
Sajid A. Haque and Nisha K. Rathi

89 Superior Vena Cava Syndrome in Critically Ill Cancer Patients 1253
Victor J. Matos

90 Catheter-Related Deep Vein Thrombosis in Critically Ill Cancer Patients 1265
Sajid A. Haque and Nisha K. Rathi

Part XIII Infectious Diseases 1273

91 Infection Prevention in Critical Care Settings 1275
Gabriela Corsi-Vasquez and Luis Ostrosky-Zeichner

92 Antimicrobial Stewardship in Critically Ill Cancer Patients 1287
Kenneth V. I. Rolston and Lior Nesher

93 Neutropenic Fever in the Intensive Care Unit 1297
R. Scott Stephens

94 Sepsis and Septic Shock in Cancer Patients 1313
Imrana Malik and Joseph L. Nates

95 Management of Multidrug-Resistant *Enterobacteriaceae* in Critically Ill Cancer Patients 1323
Juan David Plata and Ximena Castañeda

96 Fungal Infections in Cancer Patients 1337
Bruno P. Granwehr, Nikolaos V. Sipsas, and Dimitrios P. Kontoyiannis

97 Viral Infections in Critically Ill Cancer Patients 1361
Gabriela Corsi-Vasquez and Luis Ostrosky-Zeichner

98 Bacterial and Atypical Infections in Critically Ill Cancer Patients 1379
Alejandro De la Hoz and Jorge Alberto Cortés

99 Catheter- and Device-Related Infections in Critically Ill Cancer Patients 1401
Alexandre Malek and Issam Raad

100 Nosocomial Infections and Ventilator-Associated Pneumonia in Cancer Patients 1419
J. V. Divatia, Jacob George Pulinilkunnathil, and Sheila Nainan Myatra

101 Parasites in Cancer Patients 1441
Juan David Plata and Ximena Castañeda

102 Tropical Diseases in Cancer Patients 1451
Jorge Enrique Sinclair Ávila, Jorge Enrique Sinclair De Frías, and Felix Liu Wu

103 Skin and Soft Tissue Infections Among Cancer Patients 1465
Ariel D. Szvalb and Kenneth V. I. Rolston

Volume 3

Part XIV Special Patient Populations **1477**

104 Practical Approach to the Critically Ill Obstetric Patient with an Oncological Disease 1479
Sandra Olaya, Paula Velásquez, and Jacobo Bustamante

105 What the Intensivist Needs to Know About Leukemia Patients 1489
Mahesh Swaminathan and Kiran Naqvi

106 What the Intensivists Need to Know About Critically Ill Lymphoma Patients 1499
Ranjit Nair and Krina Patel

107 What the Intensivists Need to Know About Critically Ill Myeloma Patients 1513
Ranjit Nair and Krina Patel

108 What the Intensivist Needs to Know About Hematopoietic Stem Cell Transplantation? 1531
Brion V. Randolph and Stefan O. Ciurea

109 Radiation Therapy Complications Leading to Critical Illness 1547
Shalini Moningi, Geoffrey V. Martin, and Jay P. Reddy

Part XV Critical Care Procedures **1555**

110 Management of Airway in the Cancer Patients 1557
Gang Zheng and Carin A. Hagberg

111 Critical Care Procedures by the Advanced Practice Provider 1571
Ninotchka Brydges, Brandi McCall, and Garry Brydges

112 Point-of-Care Ultrasound for Oncologic Critical Care 1579
Wendell H. Williams, Anna D. Dang, and Dilip R. Thakar

113 Interventional Radiology Procedures in Critically Ill Cancer Patients 1597
Steven M. Yevich

Part XVI Perioperative Management of the Surgical Cancer Patient **1609**

114 Enhanced Recovery After Surgery (ERAS) in the Oncologic Patient 1611
Joshua Botdorf, Celia Robinson Ledet, Ninotchka Brydges, Danilo Lovinaria, and Garry Brydges

115 Neurosurgery and Post-Surgical Care of the Critically Ill Cancer Patients 1641
Gilda V. Matute and Thomas M. McHugh

116 Skull Base and Endoscopic Procedures in Cancer Patients 1653
Garry Brydges, Ninotchka Brydges, and Charles Cowles

117 Neurosurgery and Spine Procedures in Cancer Patients . . . 1667
John Wiemers and Claudio E. Tatsui

118 Neurosurgery and Pituitary Resection in Cancer Patients 1683
Nicole Luongo, Peter Slivinski, Adrian M. Smith, and Danilo Lovinaria

119 Anesthesia for Free Flap Reconstruction After Head and Neck Surgical Resection 1693
Jennifer Jones and Faisal I. Ahmad

120 Head and Neck Surgery in Oncologic Patients: Laryngectomy and Radial Neck Dissection 1709
Pamela Amakwe Uzoigwe, Maxie Pollard, and Ursula Uduak Williams

121 Plastic Surgery and Flap Graft Management of Radial Forearm, VRAM, and TRAM Flaps in Critically Ill Cancer Patients 1719
Jason Silva, Amy Jackson, and Justin Broyles

122 Perioperative Care of the Thoracic Oncologic Patient Undergoing EBUS, Thoracotomy, and Pneumonectomy . . . 1727
Marion W. Bergbauer, Johnny Dang, and George A. Eapen

123 Thoracic Surgery and Rigid Bronchoscopy 1741
Jen Chang and Mona Sarkiss

124 Thoracic Surgery and Esophagectomy 1753
Melissa Morris Puskac and Robert A. Hetz

125 Tumor Thrombectomy Overview and General Concepts . . . 1765
Yelena Livshits and Juan E. Marcano

126 Perioperative Management of the Oncologic Patient Undergoing Gastrointestinal Surgery 1775
Bobby Bellard, Jasmin Eapen, Suma Joseph, and Maxy Mathew

127 Perioperative Management of the Oncologic Patient Undergoing Cytoreductive Surgery with Hyperthermic Intraperitoneal Chemotherapy (HIPEC) 1783
Darline Hurst and Pascal Owusu-Agyemang

128 Care of the Postoperative Patient with Liver Cancer in the Intensive Care Unit 1793
Clint Westaway, Nizy Samuel, and Jean Nicolas Vauthey

129 Pancreatic Surgery in Cancer Patients 1809
Kristine McCarthy, Wei Zhang, Jose Soliz, and Danilo Lovinaria

130 Perioperative Management of the Genitourinary Oncologic Patient Undergoing Partial/Radical Nephrectomy 1825
Clarissa Stapleton, Christina Duffy, and Jonathan Duplisea

131 Total Abdominal Hysterectomy, Bilateral Salpingo-oophorectomy, and Pelvic Lymphadenectomy in Cancer Patients 1837
Ninotchka Brydges, Lesley Boyko, and Javier D. Lasala

132 Orthopedic Surgery and Femoral/Humeral Fracture Repairs 1851
Matthew John Byars and Javier D. Lasala

133 Magnetic Resonance Imaging (MRI) for the Acute Care Oncology Patient 1861
Tamra Kelly and David Ferson

134 Perioperative Management of Breast Cancer Surgery 1869
Ninotchka Brydges, La Sonya D. Malbrough, Danilo Lovinaria, and Joseph R. Ruiz

Part XVII Pain Management **1885**

135 Acute Pain in Critical Care Oncologic Patients 1887
Keyuri Popat and Catherine Vu

136 Pathophysiology, Assessment, and Treatment of Chronic Cancer Pain in Critically Ill Patients 1901
Christina Le-Short and Dhanalakshmi Koyyalagunta

137 Substance Withdrawal in ICU Environment 1913
Nuria Martínez and María-Consuelo Pintado

Part XVIII Ethics and Palliative Care **1935**

138 Ethical Issues at the End-of-Life in the Cancer Patient 1937
Colleen M. Gallagher, Jessica A. Moore, and Allen H. Roberts II

139 Palliative Care in Critically Ill Cancer Patients 1963
Ali Haider, Ahsan Azhar, and Kevin Madden

Part XIX Pediatric Oncologic Critical Care **1983**

140 Oncologic Emergencies in Pediatric Critical Care 1985
José A. Cortes and Rodrigo Mejía

141 Pain Management of Children with Terminal Cancer in the Critical Care Unit 2005
Karen Moody and Veronica Carullo

142 Delirium in the Pediatric Critical Care Oncologic Patient 2021
Sydney Nicole Ariagno and Chani Traube

143 Chimeric Antigen Receptor (CAR) T-Cell Therapy in the Pediatric Critical Care 2035
Sajad Khazal and Kris Mahadeo

Index 2049

About the Editors

Dr. Joseph L. Nates is a Professor at the University of Texas MD Anderson Cancer Center. He has lived and practiced medicine in several countries. Currently, he is the Deputy Chair of the Department of Critical Care in the Division of Anesthesiology, Critical Care, and Pain Medicine. Dr. Nates is also the Medical Director of the 70-bed Oncologic Surgical and Medical Intensive Care Units and the Founder and President of the Oncologic Critical Care Research Network (ONCCC-R-NET), a global organization dedicated to the advancement of oncologic critical care research and education. Through his organization, Dr. Nates has been leading the pioneering efforts to establish *Oncologic Critical Care* as a new subspecialty and disseminate this knowledge worldwide. As the foundation for this objective, he has led and coauthored the first two comprehensive oncologic critical care textbooks, in both Spanish and English languages. He has also established regional and global collaborative networks and organized several *Oncologic Critical Care* symposiums.

Throughout his career, Dr. Nates has occupied multiple leadership positions and received numerous awards, among them the Presidential Award for "Outstanding Achievement and Leadership for Elimination of Ventilator-Associated Pneumonia" from the Department of Health and Human Services and the four leading Critical Care Societies in the USA in 2012, the "Bill Aston Award for Quality" from the Texas Hospital Association, and Distinguished Service Award in 2015, as well as many other research awards during his career. In 2018, for his contributions to critical care, the American College of

Critical Care Medicine awarded him the title *Master of Critical Care Medicine*. The same year, for his international contributions to the development of *Oncologic Critical Care*, the Chilean Society of Critical Care and Emergency Medicine awarded him the title *International Master of Critical Care Medicine*.

Dr. Kristen J. Price was born and raised in New Orleans, Louisiana. She received her undergraduate degree in Marine Science from the University of Tampa followed by a Doctor of Medicine degree from Louisiana State University Medical Center in New Orleans. She completed an Internal Medicine residency, Chief Medical Residency, and Pulmonary and Critical Care fellowship at the University of Texas Health in Houston. Following training, she joined the faculty at the University of Texas MD Anderson Cancer Center and currently holds the title of Professor and Chair, Department of Critical Care and Respiratory Care. Under her leadership, the number of faculty and advance practice providers has grown substantially. She also oversees the Respiratory Care Department and the Section of Integrated Bioethics in Cancer Care. Dr. Price developed the multifaceted "Intensive Care Unit Organizational Infrastructure" to systematically organize, establish, and sustain evidence-based clinical, educational, and research initiatives in the ICU. Her main focus of research has been in the outcomes of critically ill oncology patients, particularly those with hematologic malignancies and respiratory failure. She is an active member of the Society of Critical Care Medicine and currently serves on the "Academic Leaders in Critical Care Medicine" task force. Dr. Price has four grown children and currently resides in Houston, Texas.

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Part I

Organization and Management of an Oncologic Critical Care Unit

Oncologic Critical Care Department Organization

1

Kristen J. Price

Contents

Introduction 4

The ICU Best Practice Committee 5
ICU Clinical Operations Committee 6
Quality and Safety Committee 7
Staff Education Committee 7
ICU Clinical Practice/Effectiveness and Evidence-Based Healthcare Committee 7
Clinical Informatics Committee 7
ICU Staff Wellness Committee 8
Patient/Family and Caregiver Engagement Committee 8
Research and Publications Committee: Critical Care 8

Conclusion 9

References 9

Abstract

Intensive care units (ICUs) are highly complex areas with the delivery of care provided by numerous disciplines with different reporting structures. These multidisciplinary care models are being redesigned as a result of increased emphasis on quality and safety, efficiency, and patient/family experience. The structure and governance of Critical Care departments vary widely in academic medical centers across the United States. Historically, ICUs were governed by individual Critical Care departments with significant focus on education, research, and training. In large centers, there can be several ICUs with completely different structure and organization. The push to improve the quality and safety of care in a streamlined and cost-efficient manner has organizations looking at more innovative ways to structure ICU care models such as institutes or centers. These "Critical Care Organizations" are few in number and are continuing to evolve at the present time. This chapter outlines The University of Texas MD Anderson Cancer Center intensive care unit organizational infrastructure which was designed over a decade and a half ago with the vision to systematically organize, establish, and sustain evidence-based clinical and

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research initiatives in our oncologic intensive care unit. While some changes in the model have occurred over time, the basic structure and function of our intensive care unit organizational infrastructure model has been remarkably stable and highly successful.

Keywords
"Oncologic Critical Care" · Organization · Administration · Committees

Introduction

Academic medical centers (AMC) in the United States have traditionally focused on patient care, education, and research, with divisions and departments within these centers often functioning in silos. This has been true of Critical Care departments whose structure and governance have varied widely. Historically, intensive care units (ICUs) have been governed by individual Critical Care departments, and in large centers, there can be several ICUs with completely different structure and organization. The highly complex nature of an ICU along with care provided by numerous disciplines with different reporting structures has led to inefficiencies and higher costs not necessarily associated with improved outcomes. Thus, multidisciplinary ICU care models are being redesigned as a result of increased emphasis on quality and safety, efficiency, and patient/family experience. This push to improve the quality and safety of care in a streamlined and cost-efficient manner has organizations looking at more innovative ways to structure ICU care models such as institutes or centers. These "Critical Care Organizations" are few in number and are continuing to evolve at the present time [1–3].

Caring for the critically ill cancer patient is particularly challenging as the critical illness must be addressed in the context of the patient's stage and prognosis from the underlying malignancy. MD Anderson Cancer Center (MDACC) is a tertiary center with cutting-edge research sought after from patients all over the world. Patients once deemed untreatable are now seeking target therapies specific to their individual malignancies. This, along with an aging population with increasing comorbidities, significantly contributes to the challenge of oncologic Critical Care. The department of Critical Care at MDACC was established in 1997 and is comprised of highly specialized faculty members who are board-certified intensivists trained in anesthesiology, pulmonary medicine, and internal medicine. In close collaboration with the primary oncology staff, and in partnership with our advanced practice providers (APP), our intensivists lead a large multidisciplinary team to provide evidence-based, state-of-the-art care to critically ill oncologic patients in a 52-bed combined medical and surgical intensive care unit (ICU). The department of Critical Care provides academic support to the Section of Integrated Ethics in Cancer Care which offers consulting services, academics, research, and policy development for all of MD Anderson's components including regional, national, and international affiliates. The Critical Care department is also responsible for providing respiratory care services throughout the entire hospital.

This chapter outlines The University of Texas MD Anderson Cancer Center intensive care unit organizational infrastructure which was designed over a decade and a half ago with the vision to systematically organize, establish, and sustain evidence-based clinical and research initiatives in our oncologic intensive care unit. While some changes in the model have occurred over time, the basic structure and function of our intensive care unit organizational infrastructure model have been remarkably stable and highly successful. When created, the vision of the multifaceted ICU organizational infrastructure model aligned with MDACC's institutional goal to "enhance the excellence, value, safety and efficiency of our patient care." The model centers around the ICU Best Practice Committee which is comprised of key leaders from all of the disciplines represented in ICU. Eight additional committees, described in this chapter, have bidirectional reporting to the ICU Best Practice Committee. Each committee, charged with developing, planning, and implementing

processes in their specialty area, is chaired by a member of the Critical Care faculty, co-chaired by a member of nursing or other disciplines' leadership, and is comprised of key multidisciplinary team members. The Best Practice Committee coordinates all activities related to the ICU initiatives to enhance best and safe patient care. ICU staff are encouraged to electronically submit ideas for process improvement projects via our Best Practice form link on the Critical Care website. The projects are vetted and sent to the appropriate committee for action. Once all project requirements are completed, that committee reports back to the Best Practice Committee for final endorsement and implementation. At the beginning of each fiscal year, every committee presents their goals to the ICU Best Practice Committee. At the end of each year, each committee summarizes their goals and accomplishments and presents their year-end summaries to the Best Practice Committee as well. A description of the organizational infrastructure as well as the purpose and goals of each committee follows.

The ICU Best Practice Committee

The ICU Best Practice (BP) Committee, chaired by the department chair of Critical Care and co-chaired by the associate director of ICU nursing, coordinates all clinical evidence-based activities related to the initiatives of the eight committees in the ICU organizational infrastructure (Fig. 1). The members of BP are, for the most part, leaders in the disciplines of ICU nursing, pharmacy, respiratory care, infection control, APP, nutrition, laboratory, social work, patient advocacy, chaplaincy, housekeeping/facilities, and information services. Each has a passion for ensuring that the best and safest care is provided to our critically ill ICU patients. The group is divided into teams of three to four, and each is responsible for performing at least one comprehensive Joint Commission endorsed tracer in the ICU per month. When at all possible, tracer feedback and education take place with the staff in real time. The data is collected, and the results of the tracers are discussed at each Best Practice meeting. The data is trended, and quarterly reports are generated which are reviewed, posted on our internal website, and reported up to the institution's senior leadership.

Committee membership is critically reviewed on an annual basis to ensure attendance and engagement. There are three standing strategic goals of the BP committee:

1. To enhance best practices in the department of Critical Care, utilizing an evidence-based and a clinical effectiveness approach
2. To enhance quality and safety initiatives in the ICU, utilizing an interdisciplinary approach with collaboration and cooperation among appropriate disciplines at MD Anderson Cancer Center
3. To enhance clinical outcome measurements of the ICU infrastructure and support the implementation of any corresponding action plans

A critical summary is performed by the group at the end of every fiscal year; often, new goals are added and removed as needed.

The BP committee has two meetings per month on the first and third Wednesdays. The core group meets on the first with standing reports from each of the disciplines and a detailed review of the tracer reports. All new projects submitted electronically are reviewed and assigned to the appropriate infrastructure committee for analysis. The second meeting of the month follows the same format; however, the chairs and/or co-chairs of all of the infrastructure committees are present to give updates on all of the activities and projects they are engaged in. Once projects are completed and endorsed by the BP committee, they are funneled through the staff education committee who determine which disciplines need to be educated on that particular project. The need for cyclical education is also determined and carried out under this committee.

The adequate coordination of all committees is pivotal to keep the unit functioning at a high level of organization and productivity.

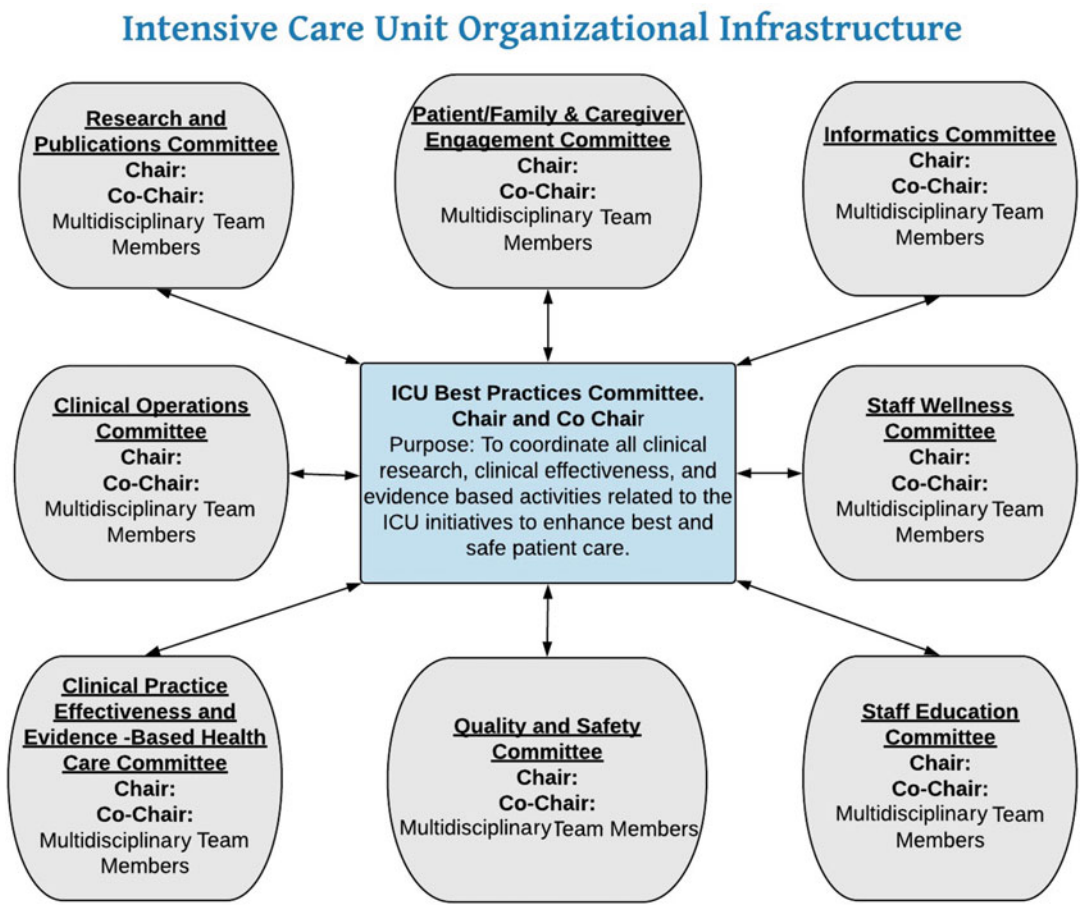

Fig. 1 Intensive care unit organizational infrastructure model

ICU Clinical Operations Committee

Purpose: To continuously review and improve clinical and operational practices in the intensive care unit (ICU)

General Goals

1. Monitor daily clinical activities and develop strategies to correct ineffective practices in the ICU.
2. Generate, support, and implement strategies to deliver excellent patient care.
3. Implement policies recommended by government agencies (e.g., Centers for Disease Control, Agency for Healthcare Research and Quality) to improve safety and prevent and ultimately abolish preventable complications (e.g., ventilator-associated pneumonia, catheter-related blood stream infections, wound infections).
4. Evaluate quality indicators pertaining to operational issues in the ICU.
5. Advise the Best Practice Committee on projects with foreseeable positive impact on administrative, clinical, and economical outcomes (quality improvement and clinical practices projects).
6. To increase patient safety by continuing to work with legal to finalize an institutional policy regarding audio and videotaping in the ICU.
7. To review the implementation of the rounding checklist.

8. To collaborate with Best Practice regarding the possible implementation of an intermediate unit.
9. Continue to sustain the initiatives implemented by the SCCM collaborative workgroup.
10. Implement the massive transfusion protocol for the ICU.

Quality and Safety Committee

Purpose: To identify and address opportunities to continuously improve organizational processes that will positively affect patient outcomes and patient satisfaction as well as lower costs for the ICU

General Goals

1. To continue to monitor current multidisciplinary indicators and add new indicators as appropriate to the quality and safety report
2. To review ICU data on multidisciplinary incident reports, errors, and high-risk clinical activities and develop plans and interventions to reduce risks and improve system and care processes to prevent such events
3. To collaborate with the Best Practice Committee on Joint Commission initiatives and Best Practice projects
4. To consolidate, analyze, and disseminate information via the ICU Best Practice Committee monthly and the institution's Acute and Critical Care Subcommittee meetings as needed
5. Specific committee goals include:
   (a) Report compliance on universal protocol/time-outs on a quarterly basis
   (b) Establish a monthly quality and safety report in collaboration with the epic team
   (c) Continue the device-related infection control ad hoc group to evaluate each CLABSI and add any incidences of CAUTI and PVAP for full review
   (d) Continue early nutrition initiative to evaluate sustainability of FY 18 project with identification of interventions to promote early nutrition in the ICU

Staff Education Committee

Purpose: To promote and coordinate the education of ICU staff, patients and families, faculty, fellows, advanced practice providers, residents, and students

General Goals

1. To provide instruction to the ICU staff, faculty, fellows, advanced practice providers, residents, and students on all new or updated order sets and protocols.
2. To provide instruction to the ICU staff, faculty, fellows, advanced practice providers, residents, and students on the Joint Commission guidelines based on tracer round results.
3. To continue to provide education for fellows, residents, and students with didactic lectures and bedside teaching.
4. To continue to support nursing staff development.
5. To educate the ICU staff on new or updated ICU operations.
6. To continue to implement education for identified low-compliance areas.

ICU Clinical Practice/Effectiveness and Evidence-Based Healthcare Committee

Purpose: To coordinate, evaluate, and recommend practice changes related to ICU operations and patient care

General Goals

1. To facilitate practice changes in clinical care for enhancing patient care experience.
2. Reduce practice variability through the implementation of standardized order sets and/or algorithms.
3. Enhance multidisciplinary planning to ensure safe delivery of patient care.

Clinical Informatics Committee

Purpose: A multidisciplinary group focused on informatics issues in the Critical Care environment to include electronic health record issues

and enhancements, IT devices used in our environment, and quality and performance improvement projects with an informatics focus.

General Goals

1. Continue to address incoming concerns with our new electronic health record.
2. Review and prioritize parking lot issues for optimization.
3. Periodic evaluation and revision of documentation for efficiency and compliance.

ICU Staff Wellness Committee

Purpose: Take the lead in exploring ways to provide emotional and social well-being to our staff and to provide programs/activities addressing the needs of staff

General Goals

1. The committee will continue to provide emotional well-being to the ICU staff by providing four quarterly debriefing sessions.
2. The committee will continue to provide emotional well-being stress relief opportunities by hosting a stress busters twice a quarter.
3. The committee will provide a staff survey to determine areas of need for overall wellness (e.g., meditation room; working mothers' room).

Patient/Family and Caregiver Engagement Committee

Purpose: Create a more patient- and family-centered environment and facilitate healing through enhanced communication and empowerment

General Goals

1. Enhance the use of a daily goal board with a multidisciplinary approach.
2. Review current visitation guidelines and amend to include open visitation.
3. Encourage patients and families to be active participants in the healing process.
4. Improve the overall experience for patients and families through enhanced communication, engagement, and empowerment.

Research and Publications Committee: Critical Care

Purpose: To encourage research and publication in the Critical Care department by enhancing collaborations within the department and other departments

1. To maintain a current and updated list of all research projects, case reports, and QI projects that might lead to publications from all Critical Care staff
2. To enhance the involvement of all Critical Care staff in research activities and guide them in the process
3. To encourage department members to present their research findings to other faculty and staff in the department.

General Goals

The following significant changes were made in the past fiscal year:

1. A biyearly newsletter continues to be published updating all Critical Care staff regarding all ongoing projects, published abstracts, and papers.
2. The "Frontiers in Critical Care Multidisciplinary Research Sessions" were a success with presenters from different disciplines presented (MDs, APPs, pharmD).
3. Two vetting process through the committee for all prospective studies in the ICU is in place.
4. We have continued an updated list of all ICU staff projects (includes faculty, nursing, APPs, and pharmacy) which can be found at the research committee website http://inside.mdanderson.org/departments/ccm/icu-research-and-publications-committee.html.
5. We have kept an updated list of all congress relevant to Critical Care, for people to have access to.

New Committee Objectives

1. Will continue to maintain a list of *departmental resources and projects* via the research website.
2. Continue newsletters and quarterly/semester meetings with the committee.
3. The "Frontiers in Critical Care Multidisciplinary Research Sessions" will now invite researchers from other specialties to present their studies that are relevant to Critical Care (i.e., lymphoma and cardiology).
4. We will see if we can record the "Frontiers in Critical Care Multidisciplinary Research Sessions" so that all staff can access it if they were unable to attend to the talk.
5. The committee will guide APPs in the following: creating research ideas and identifying objectives, developing and writing of protocols for IRB or QI approval, understanding of statistical analysis of data, and writing abstracts and manuscripts.

Conclusion

The ICU organizational infrastructure was developed to bring the multidisciplinary team members together for the purpose of establishing and sustaining evidence-based clinical patient safety initiatives. This novel staffing model brings together all disciplines with different reporting structures to focus on efficiency and appropriate resource utilization in our critically ill oncologic patients. While the basic structure of each committee is the same, each chair and co-chair has autonomy in the way they select members, conduct their meetings, complete projects, and accomplish their goals each year. Listing specific accomplishments of each committee is beyond the scope of this chapter; however, quite remarkably, the model has been sustained for over two decades now. Committees have been added and retired under the governance of the multidisciplinary infrastructure, and the results have been truly outstanding. As regulations and reimbursement processes continue to be based on value and outcomes, academic medical centers will face ongoing challenges in the years to come. As Critical Care Organizations continue to evolve, models such as our ICU organizational infrastructure will be instrumental in improving the quality and safety of care in a streamlined efficient manner.

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ICU Utilization

2

Current Trends in ICU Beds, Use, Occupancy, and Costs in the United States

Karen Chen, Susannah K. Wallace, and Joseph L. Nates

Contents

Introduction 12
ICU Beds and Utilization 12
ICU and Hospital Mortality 13
Costs 14
Specialty ICUs 14
Best Practices in ICU Optimization 15
Critical Care Organizations 15
Conclusion 16
References 16

Abstract

Oncologic critical care units specialize in the care of patients with critical illness related to their malignancy, treatment, or other conditions. Intensive care unit (ICU) beds, utilization, and costs have continuously increased in general acute care hospitals in the United States over the past three decades. This chapter reviews and summarizes current literature related to ICU beds, utilization, and costs in general and oncologic critical care units as well as recommendations to improve access, quality, and costs of healthcare. The concept of the specialty ICU and its associated outcomes is briefly covered. Evidence-based recommendations of best practices for ICU resource optimization are delineated. In conclusion, effective critical care organizations will develop and align the multiple facets of research, quality improvement, culture of safety, and outcomes to improve the value of critical care units in healthcare delivery.

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Keywords
ICU beds · Utilization · Optimization · Mortality · Costs · Quality · Value · Outcomes · Specialty ICU · Critical care organizations

Introduction

There is significant variation in treatment of the same disease by physicians and hospitals throughout the United States [40]. In addition, there is no systematic classification and organization of intensive care units; some combine MICU and SICU, some have subspecialty ICUs, whereas community hospitals may place less sick patients in the ICU solely for more concentrated nursing care. Furthermore, there is no national database describing ICU utilization with any specific details due to this lack of a standardized definition and reasons for admission to intensive care units.

Unfortunately, this poses a problem as to comparative groups. Based on the literature available, it appears that less than half and in some circumstances as low as 10–20% of the ICU patients require the most intensive treatment described as "fairly continuous physician involvement and various forms of life support" [45, 26]. On the other end of the spectrum, patients who receive monitoring and intensive nursing care make up about 20–30% of patients in general ICUs, with a higher percentage of "monitoring" patients in ICUs which also serve as CCUs.

ICU Beds and Utilization

Between 2000 and 2010, the number of ICU beds in non-federal acute care hospitals in the United States has increased from 88,235 to 103,900 (17.8%). The ratio of ICU to total hospital beds has also increased from 13.5% to 16.2% (a change of 20.4%) [15].

There are significant variations in ICU practices and policies throughout the healthcare system thus highly impacting ICU utilization rates. Many of these factors, such as practitioner discretion, hospital capacity, policies, and procedures of the hospital, are based on subjective and at times arbitrary considerations as opposed to evidence-based decisions. In a study conducted within the US Veterans Affairs Health System, the rate of ICU admission for low-risk hospitalized patients varied from 1.2% to 38.9% [9]. In this same study, the variations in the ICU utilization did not alter outcomes. Thus, many of these patients should have been treated in less acute lower cost settings [9]. In addition, when patients are unnecessarily placed in ICUs or keeping them in the ICU longer than necessary may cause harm in the form of complications such as increased healthcare- associated infections, medication errors, adverse drug events, agitation, and delirium with associated long-lasting sequelae [19, 20, 29].

In a different study, certain conditions such as DKA, GI bleed, PE, CHF which frequently utilize ICU care but which may not always be necessary, institutions that utilized ICUs more frequently performed more invasive procedures and incurred higher costs but had no improvement in hospital mortality. Of note, many of these hospitals with high ICU utilization were small (<99 beds) or teaching hospitals, thus ICU admission provided either specialized nursing or physician skill sets [5]. In this study, hospitals had similar ICU utilization patterns across the conditions [5]. However, lack of clear-cut guidelines for ICU admissions and differences in institutional resources, policies, and culture have resulted in significant variability in utilization among hospitals [1, 8, 43]. Thus, Chang and Shapiro concluded, in order to improve the value of critical care services, factors that lead clinicians to admit to a higher level of care when equivalent care can be delivered in a less costly setting will need to be addressed by the institutions within the confine of their healthcare system [5].

In another study, many patients who required monitoring but no acute ICU intervention may not have needed ICU-level care but benefitted from higher level of care than that available on a regular medical/surgical ward. This suggests that an increased allocation of intermediate care unit beds likely will improve ICU resource utilization [26]. In a single center oncology unit, this theory was once again demonstrated by decreased ICU

utilization rate over time with the advent of surgical intermediate units as noted by Wallace [41].

Contrary to popular belief that elderly people may require more intensive care than their proportion of the general population or that the elderly might receive less intensive care than their younger counterparts due to scarcity of ICU beds, analysis of the data does not show this [16]. As opposed to other developed countries, age does not appear to be an important determination for ICU admission in the United States based on MEDPAR data showing about 15–18% of beneficiaries utilizing the ICU or CCU for various age groups ranging from <65 to >85 years [16].

In 2010, the average national ICU occupancy rate based on the midnight bed census was 66% [14]. A 2005–2007 study using Project IMPACT data reported a mean hourly ICU occupancy rate of 68.2% [44]. According to a 2003 SCCM survey [46], occupancy was highest in Surgical ICUs (79%), ICUs in federal hospitals (80%), and ICUs of hospitals with 301–750 beds (77%). Mortality remained stable despite variations in the occupancy rate [18]. Unfortunately, the data sets used in these large national studies did not include specific information regarding oncologic critical care.

Due to early detection and more treatment options for cancer, survival of cancer patients has increased over the last three decades [4]. Unfortunately, many of these therapies cause increased side effects and significant toxicities that require life support and/or life-sustaining measures, which have resulted in ICU referrals and admissions [2].

It is estimated that as high as 20% of patients admitted to ICUs hold a cancer diagnosis [7, 34]. The authors found that the presence of clinical pharmacists in the ICU, presence of ICU protocols, and daily meetings between oncologists and intensivists were associated with lower hospital mortality even after adjustment for hospital case volume [35]. Protocols and daily meetings were also associated with more efficient resource utilization [35].

Wallace et al. [41] described the results of two decades of ICU utilization and hospital outcomes in a comprehensive cancer center in the United States. The ratio of ICU to total hospital beds was 8.2% in 2013 and remained stable throughout the time period. ICU utilization was 12% and decreased over time with the advent of specialty step-down units such as surgical intermediate care units and neuro progressive units. Average ICU and hospital lengths of stay were 3.9 and 7.4 days, respectively, in comparison to patients in general hospitals with average lengths of stay of 4.4 days [41].

The proportion of hospital days spent in the ICU (6.9%) was lower than that in national studies (14.4–21.1%). Patients with cancer are often admitted to the hospital to receive anticancer therapy which may account for the lower percentage [41]. Given the increase in the incidence of cancer and improved survival rates along with more chemotherapeutic and surgical options, cancer patients are requiring advanced life support for cancer-related complications, treatment-related toxicities, and severe infections [22]. Some examples include structural problems such as spinal cord compression, superior vena cava syndrome, and cerebral metastasis with associated edema; metabolic problems such as hypercalcemia, tumor lysis syndrome, hyponatremia related to syndrome of inappropriate antidiuretic hormone; and hematologic problems such as hyperleukocytosis and leukostasis, disseminated intravascular coagulation, and infectious problems due to myelosuppression. Length of stay varies by service line. For example, length of stay for hematopoietic stem cell transplantation recipients increased over time possibly due to the increasing use of cord blood and haploidentical transplants which require a longer time to achieve hematologic recovery [41].

ICU and Hospital Mortality

In a JAMA study published in 2013, a comparison of data between 2009, 2005, and 2000 showed a lower percentage of patients died in an acute care hospital in 2009 as compared to 2005 and 2000 but admission to ICU and the rate of health care transitions increased in the last 30 days of life, despite growth in hospital-based palliative

services [39]. This study questions the notion that there is a trend toward less aggressive care at the end-of-life as reported by the CDC based on the fact that more patients aged 65 and older were likely to die at home [39].

Wallace et al. in a 20 year study of ICU utilization and outcomes reported hospital mortality to be 3.6% among patients with cancer: 16.2% among patients with an ICU stay and 1.8% among non-ICU patients [41]. The observed mortality rate was less than the expected mortality rate for almost all services, and the overall standardized mortality ratio was 0.71. The hospital mortality rates were 3.9% for surgical ICU patients and 33.8% for medical ICU patients (42.7% in the hematological patients and 25.2% in the solid tumor patients).

ICU mortality rates vary by type of malignancy and are reported to be 18.3–31.2% among patients with solid tumor malignancies, 36.6–47.8% in patients with leukemia, and 27.8–50.0% in patients with lymphoma [17, 31, 41]. Over the past two decades, there has been a decreasing hospital mortality for hematopoietic stem cell transplantation recipients thought to be due to reduced intensity conditioning regimens and other global changes in pretransplant protocols [10, 41].

Costs

Intensive care unit utilization contributes to a significant portion of health care costs. In 2010, intensive care services accounted for 13.2% of total hospital expenditures, 4.1% of national healthcare expenditures, and 0.72% of the gross domestic product [15]. Annual costs for critical care services increased by 92.2% from $56 to $108 billion dollars between 2000 and 2010, which was double the rate of increase of the GDP during the same time period. The proportion of critical care costs to GDP increased 32.1%. Hospital stays that involved ICU services were two and a half times more costly than other hospital stays. Hospital stays with ICU services accounted for just over one-quarter of all discharges (26.9%) but nearly one-half of aggregate total hospital charges (47.5%) [3].

Intensive care is also expensive. And the Medicare reimbursement rate for intensive care covers only 83% of its costs as compared to 105% in those without an ICU stay [6]. In this chapter, an analysis performed in the year 2000 analyzing costs and reimbursements concluded that hospitals lose money on patients who spend at least 1 day in an ICU versus making money on those patients that do not spend any times in ICUs [6].

Several initiatives have been established to decrease ICU utilization and contain costs such as noninvasive mechanical ventilation, intermediate or low intensity surgical patients, and palliative and end-of-life care outside of the ICU. Other initiatives include patient safety and quality mandates, participating in hospital performance metrics, optimizing ICU design, staffing and coverage mechanisms, maximizing ICU throughput and patient flow, dealing with capacity strain, rationing ICU beds, containing ICU costs, standardizing ICU technologies and alarms, developing and managing rapid response and sepsis teams, and fostering interdisciplinary collaboration and interacting with hospital networks in critical care organizations [24].

Specialty ICUs

Do critically ill patients in ICUs at cancer centers perform better than those in ICUs at general hospitals after adjustment for severity? The findings in ORCHESTRA suggest that admission to an ICU in cancer centers was not associated with lower ICU mortality, hospital mortality, or better resource utilization when compared to ICU admissions in general hospitals [22, 34]. In a more recent study by Romano et al., early palliative care in oncologic patients significantly reduced the utilization of ICU services and in hospital mortality but does not change utilization of chemotherapy or radiation therapy [32]. Although palliative care has not shown an impact on critically ill patients, it has shown improved survival and improved quality of life in ambulatory cancer patients [38]. In a large European study, patients with cancer were more often admitted to the ICU for sepsis and respiratory complications than other ICU patients. Overall, the outcome of patients with solid cancer was similar to that of ICU patients without cancer,

whereas patients with hematological cancer had a worse outcome [37].

Although ICU patients with cancer still have a higher mortality than ICU patients without malignancy, published survival rates of critically ill patients with cancer are approaching those of severely ill patients without cancer, and it no longer seems justified to universally deny patients with cancer access to intensive care medicine [33]. Of utmost importance, close collaboration among medical and surgical oncologists with the intensivists will ensure the establishment of clear goals and a multidisciplinary approach to treatment for every patient with cancer who requires ICU admission [11].

Best Practices in ICU Optimization

Although implementing change to optimize ICU utilization is quite a formidable task, significant potential benefits, including but not limited to improved patient outcomes, increased bed capacity and patient throughput, decreased payment penalties, as well as increased patient satisfaction, abound for an organization that succeeds in this realm [24]. Accurate data to drive change cannot be overly emphasized in this challenging but rewarding endeavor.

Here are some common tenets and best practices in ICU resource utilization management [24]. First, establishing and diligently using care bundles. These bundles are usually implemented as a checklist to reduce the complications of ICU care, namely, infections, pain, delirium, immobility, prolonged ventilatory support, etc. [25, 30]. Secondly, establishing end-of-life planning and palliative care treatment plans can improve patient satisfaction, duration of survival while reducing ICU length of stay and ICU admissions thus reducing ICU costs [21, 38]. Thirdly, establishing admission, discharge, and triage criteria as well as operating an intermediate care unit [28, 36]. Fourthly, multidisciplinary teams daily rounding utilizing checklists have shown improved patient outcomes as well as decreased length in ICU stay [42]. Fifthly, ICU staffing that includes a specialty team led by an intensivist, a board-certified physician with advanced training who provides specialty care to critically ill complex patient [42]. Finally, there needs to be focused ongoing review of operational efficiencies, variations in practice, and outcomes leading to a quality metric scorecard and a performance improvement plan [24].

Critical Care Organizations

Changing healthcare regulations and reimbursement structures provide challenges for hospitals and healthcare systems. The Society of Critical Care Medicine developed a task force of successful leaders of critical care organizations in North America to provide guidelines for adult critical care medicine leaders in academic and non-academic settings [27]. The task force members have expertise in critical care administration, healthcare management, and clinical practice. They describe two phases of care integration within critical care organizations: horizontal – an initial phase that includes regionalization of care, and vertical, which includes continuum of care following acute and intensive care.

After integration of business and operational aspects of critical care, the next step is to integrate critical care organizations within academic medical centers to improve healthcare delivery. The key elements of critical care organizations include patient care and safety, quality improvement, research, education, and professional development [23]. The culture of safety should include reporting, review, and open discussion of adverse events, patient safety education, and checklist development. Seamless interoperability between electronic health records and incident reporting systems is important to improve value for patients. Clinical outcomes, health services research, quality improvement benchmarking, and the use of severity scoring systems (APACHE, MPM, SAPS) are important for describing the population health of critical care organizations. As a result of technological advancements, electronic health records, publicly reported metrics, emphasis on patient safety and experience, in addition to the value of care, critical care organizations will need to effectively and efficiently utilize their resources.

Conclusion

As there is no standardized classification system for intensive care units and reasons for ICU admission, ICU utilization may vary significantly from hospital to hospital. As high as 20% of patients admitted to general ICUs carry a cancer diagnosis [34]. Wallace et al. described the results of two decades of ICU utilization and found hospital mortality reported to be 3.6% among patients with cancer, 16.2% among patients with an ICU stay, and 1.8% among non-ICU patients [41]. The observed mortality rate was less than the expected mortality rate for almost all services, and the overall standardized mortality ratio was 0.71. As ICU utilization contributes to a significant proportion of health care costs and with costs rising, several initiatives have been established to decrease ICU utilization and contain costs such as noninvasive mechanical ventilation, intermediate or low intensity surgical patients, and palliative and end-of-life care outside of the ICU just to name a few. In addition, best practices such as utilizing checklists, multidisciplinary team rounds led by intensivists, establishing admission, discharge and triage criteria, as well as tracking performance metrics in a quality improvement plan will improve ICU utilization optimization. In the future, two phases of care will need to be integrated within critical care organizations. Horizontal integration which includes regionalization of care and a vertical one that incorporates the continuum of medical care following the ICU stay [27].

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Critical Care Admissions and Discharge Criteria in Cancer Patients

3

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Contents

Introduction 20
What Has Changed to Improve the Prognosis of Cancer Patients in ICUs? 20
Better Results, but at What Cost? 22
Organizational Aspects of the ICUs 22

Admission Criteria 24
The Patient and Their Characteristics 24
Tumor Type and Stage 26
Reason for Admission 26
New Strategies of ICU Admission 27

ICU Discharge 27

Summary 30

References 30

Abstract

More and more patients with solid or hematological tumors are admitted to the Intensive Care Units. The improvement in the physiopathological understanding of this group of patients, as well as the increasingly better and more targeted treatment options for their underlying disease, has led to a significant increase in their survival over the past two decades. We are living in an era in which we are defining the standards that offer the best way to care for them: From the organization and running of ICUs, the definition of clear admission criteria from the available evidence, and the development of new admission policies that expand the classic dichotomous view of whether or not they are candidates for admission to ICUs to analyzing the best treatment for them, avoiding excessive treatment, and, above all, respecting their principle of autonomy.

Keywords

Oncologic patients · Admission policies · Multidisciplinary care · Early response team · Critical care transition programs · Full code admission · ICU trial · Palliative care

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Introduction

Cancer patients are increasingly common in intensive care units around the world. One out of every six to eight patients admitted to intensive care units (ICUs) worldwide presents a neoproliferative process [1, 3]. Those of us who treated this type of patient two decades ago in hospitals dedicated to cancer treatment were accused of using very expensive resources in patients with a short life expectancy. At the time, some scientific societies, such as the American College of Chest Physicians or the Society of Critical Care Medicine in its 1992 Consensus Conference, pointed out the futility of admitting oncology patients to Intensive Care Units, arguing that if they needed mechanical ventilation, catecholamine, or renal replacement therapies, their mortality rate of over 90% was not worth the therapeutic effort. At the time, the fact of being a cancer patient was an independent risk factor for refusing to admit the patient to the ICUs [2].

The incidence of cancer does not stop growing; diagnosis is made at an earlier stage, which increases the treatment and life expectancy of these patients; the social and healthcare level in developed countries increases, and we find ourselves with an increasingly aging population and therefore more prone to suffering mutations in genetic structure that make it develop a neo-formative process. The age-adjusted incidence of cancer is 533.8 cases (532.6–535.1) per 100,000 population with a 95% CI [3]. To give you an idea of its magnitude, in 2009 there were 1.4 million and 3.2 million newly diagnosed cases of cancer in the USA and Europe, respectively (100,000 and 230,000 cases of oncological blood disorders in the same period). And this increase in the number of cases leads to more and more people being admitted to Intensive Care Units. During the first 100 days after the diagnosis of cancer, the risk of entering the ICU is considerably high and this exponential growth is subsequently reduced. Nearly 5.2% of all cancer patients develop a complication requiring ICU admission within 2 years of diagnosis [4]. If we are talking about patients with allogeneic hematopoietic stem cell transplantation (HSCT), up to 20% of them will require ICU admission after their procedure.

This whole process is underpinned by scientific research. While the first studies on cancer patients in the 1990s were rare and merely observational about their occurrence and survival (mainly developed in France, Brazil, and the USA), today, on the other hand, there is a proliferation of articles written all across the world by single-unit ICUs, general ICUs, including multicentric ICUs that bring together large numbers of patients. Contributions include retrospective or prospective articles aimed both at describing the experience of specialized centers with regard to their patients, for example with lung cancer [5] or after cytoreductive surgery Mogal et al. [51], and above all, studies aimed at reviewing signs of admission, studies that assess factors that influence their short- and long-term prognosis or those aimed at finding the best organization of units to treat them [6]. The societies of Intensive Care and Oncology seek meeting points and create work units to improve the outcome for their patients, as is the case with the SEOM and SEMICYUC in Spain [7]. A section within the new working guidelines [8] on admission, discharge criteria, and patient triage from the Society of Critical Care Medicine (SCCCM) has included a section on the admission criteria for cancer patients.

What Has Changed to Improve the Prognosis of Cancer Patients in ICUs?

Comparative mortality studies have shown a significant improvement in the life expectancy of cancer patients in ICUs in recent years. Of these, the systematic reviews of Puxty et al. [4] and Soubani [9] are noteworthy. The first one deals with the review of 48 articles between 1997 and 2011 with a total of 74,061 patients with solid tumors in which the overall mortality in ICU was 31.2% and in hospitalized patients 38.2%, but with such a wide range of intra-Intensive Care Unit mortality between 4.5% and 85% due to the great heterogeneity of the sample. Soubani [9] compares studies from the 1980s and 1990s

where mortality of patients with cancer and mechanical ventilation was around 80–90%, while more recent studies describe mortalities between 27% and 30% in solid tumors, 40% in autologous transplants, and around 60% in allogeneic transplants.

The reasons for this improvement in outcome results are multifactorial and due to improvements and innovations in all fields of cancer research, diagnosis, and treatment, as well as intensive care.

In the field of Critical Care, the main change has been the return to the physiological understanding of the different pathologies and its application in their treatment. Understanding and using optimal peep, limiting plateau pressure or tidal volume, meaning of the response or non-response to volume administration during resuscitation, assessing weaning-related cardiac dysfunction, limiting airway pressure to optimize cardiovascular function, understanding why prone positioning minimizes lung damage and improves gas exchange, understanding that small changes in creatinine can lead to significant kidney damage, all of these are some examples of practices that we all develop today and whose basis is our physiology [10]. The use of noninvasive ventilation or high-flow systems capable of generating positive pressure has been shown to be effective in reducing intubation and mortality due to respiratory distress [11]. Improvements in sedation and analgesia techniques, with less depth in them and with periodic interruptions to improve weaning; being attentive to the psychological needs of the patient and the family, preventing and diagnosing delirium of our critical patients early; the daily use for bedside diagnosis or for safer techniques through ultrasound; the improvement of nutrition for critical patients; better understanding of common processes such as polyneuropathy or myopathy of the critically ill, etc., and thus small advances in all areas of intensive care have contributed to a more physiological and less aggressive management of our patients. From an organizational point of view, the systematic work carried out using operating protocols, the progressive distribution of our Intensive Care Units and medium level units according to the need for monitoring, the complexity of each patient, and the nursing care ratios allow us to attend to each of our patients with a specific level of priority, thereby being more cost-effective.

In the field of Oncology, surgery is becoming more and more sophisticated, more advanced supplemented before, after, and even at the same time with chemotherapy or radiotherapy. Other developments include advances in conventional RT or brachytherapy, improving optimal doses and minimizing damage to healthy tissues, development, and augmentation of proton RT indications. Furthermore, we have the increasingly physiological hormone therapy in those dependent tumors and the great advancement in immunotherapy. Regarding chemotherapy, on the one hand, the use of intensive schemes that allow a greater response or cure and, on the other, the development of therapies directed at certain genetic and biological targets.

Just as important as these advances are, there is also the development of a better and earlier supportive treatment: nutritional, psychological, and pharmacological; the importance of a correct nutritional and psychological assessment to prepare the patient for treatment. Other factors include pharmacological development with potent antiemetics, granulocyte stimulators that decrease the duration of neutropenia, and new bisphosphonates or recombinant rasburicase that decrease the toxicity of chemotherapy.

Nowadays, early diagnosis of infections is fundamental through the systematic use of b-D glucan, galactomannan, PCR, or procalcitonin tests [12] as well as the use of noninvasive ventilation (NIV) or high-flow devices to perform fibrobronchoscopies and thus obtain samples for culture. Also the early use of better targeted antibiotics and the development of new antifungals and antibiotics after a long period without new patents have caused mortality around the treatment to decrease. Because of all this, from the 1990s to the present day, mortality from cancer has fallen by 23% [13].

But multidisciplinary collaboration and patient care decisions between oncologists, hematologists, and Intensive Care specialists have undoubtedly been fundamental, as demonstrated in numerous articles such as Soares et al. [6]. Primary care

physicians are able to inform us of the prognosis, treatment options, and adverse effects of the traditional and new chemotherapy regimens. Intensivists can make the overall situation about the patient be understood from the real expectation of the medical situation that is being developed. And together, a plan can be agreed on in terms of time, in terms of limiting efforts, and together informing the patient and the family. The inclusion of other specialists such as pharmacists in cancer patient care has been shown to be beneficial because of the combination of polymedication and potential toxicity and interactions [6].

Better Results, but at What Cost?

The cost of this improvement in survival rates entails not only economic costs, even though this is very high (the cost of intensive care beds amounts to between 16.9% and 38.4% of hospital costs; approximately 200 billion dollars per year) but also more and more sick people those are dying in our units. A US review of Medicare of over 85,000,000 patients shows that the percentage of patients who were in ICU in their last month of life increased [14], rising from 24.3% in 2000 to 29.2% in 2009. Because of this, it has come to be considered as a quality measurement factor in many health care systems. Although the majority of cancer patients would prefer to die at home, the truth is that in the USA 40% of citizens die in hospital and nearly 60% do so after being admitted to the ICUs. One in five Americans dies in our units.

Organizational Aspects of the ICUs

In the following points, we will describe what organizational characteristics of our Intensive Care Units have proven to be beneficial in the treatment of cancer patients.

Oncologic vs General ICUs: Volume of Cases

With the first studies there seemed to be a difference in mortality in favour of ICUs specialising in cancer, mainly due to the large volume of admissions to intensive care. Patients with cancer and ARDS or septic shock had a mortality rate of between 34% and 50% when they were managed in oncology specialized ICUs while it raise to 66–68% in general ICUs [15]. Little by little, due to the transmission of knowledge and the monitoring of standardized protocols, this gap is gradually narrowing to practically the same level. Soares et al. [6] in a study of 9,946 patients with solid tumors could not demonstrate that the higher number of cases or the specialization of the ICU were determining factors for improving outcomes in these patients.

Multidisciplinary Care

Each day the ICUs are becoming less closed off and there is greater collaboration with a large number of specialists: oncologists, hematologists, specialists in infectious diseases, nephrologists, cardiologists, pneumologists, pharmacologists, etc. Although the daily burden of decision-making lies with the intensivist, there is more and more joint work with these specialists, both in terms of carrying out complementary tests and for consulting on specific problems or the progression of the illness. The development of working protocols in ICUs has also been shown to decrease the mortality of our patients, including general protocols for infection prevention, initiating early enteral nutrition, developing protective mechanical ventilation, using intermittent sedation, beginning physiotherapy and early mobilization, etc.

When deciding on admission to the ICU, several studies ([16]; Nasir et al. [17]) have shown that although a joint assessment by several specialists may be useful, it is the intensivist, due to his global assessment of the patient and experience in making such decisions, who is best placed to approach the reality of the process and who can best prevent inappropriate admissions (up to 37% according to Nasir et al. [17]), avoiding both aggressive procedures, family and patient stress, as well as delaying access to quality palliative care.

Joint daily sessions between intensivists and oncologists/hematologists for decision-making

and the presence of a clinical pharmacologist on the rounds are associated with a reduction in mortality in critical oncology patients [6]. In addition, the presence of palliative care specialists on the rounds helps to improve patient comfort, improve symptom control, communication, and family participation in decisions.

Early Warning and Admissions

The importance of early detection of multi-organic dysfunction outside intensive care units has been noted for some time now; for this reason, "out of wall" ICU strategies have been developed over years to recognize this early dysfunction by means of early intervention teams or the active assessment of frail patients by intensivists. Song et al. [52] demonstrated in a general hospital that those patients who are transferred to the ICU early (four-hour cut-off point) have significantly lower mortality rates, lower costs, and significantly shorter hospital stays. Oncohematological patients are fragile patients, their immunological and nutritional status and the toxicity of their treatments make them particularly sensitive to a rapid deterioration in their physical functioning if something happens that makes them unstable. Therefore, early intervention in these patients is perhaps more important and evident than in the case of other sufferers. Recent studies carried out in Seoul [18] show that prompt care (<1.5 h after detecting the anomaly and assessing it) with respect to late care (>1.5 h) was accompanied by lower mortality in ICU (18.1% vs. 42.4%) and for hospital care (29% vs. 55.3%). Late care was also accompanied by increased need for vasoactive drugs, more severe neutropenia, and documented infection data.

Two multicentric studies in hematological [19] or oncological patients undergoing shock [20] show that delaying their admission to ICUs is an independent mortality factor.

The benefit is clearly associated with aggressive and early treatment of multi-organ dysfunction and prevention of organ failure. And within this group, tests or risk procedures would be performed on our patients in a safer and more controlled environment such as our ICUs.

Admission Policies

The decision to admit a patient to the ICU has always had a certain interpersonal and variable component; this is even more evident with cancer patients because of an ICU doctor's memory of not admitting them.

A study by Thiery et al. [21] showed that in a tertiary hospital, when cancer patients were referred to the ICU, 50% of them were rejected, with the label "cancer" being the main reason for their rejection. The 20% who were not admitted because they were "too well to be admitted" died before leaving the hospital and the 25% of patients who were initially rejected and subsequently admitted to the ICU left the hospital alive. This shows how difficult it is to get the admission decision right.

For all these reasons, admission policies in Intensive Care are changing and recommendations are being sought based on best practices and available evidence. All of them have a low level of evidence except the high-intensity ICU model characterized by the intensivist being responsible for day-to-day management of the patient in a closed ICU setting (level of evidence 1B) [8]. In the specific case of cancer patients, the SCCM recommends (no evidence available):

- Access to ICU on the basis established for all critical care patients, with careful consideration of their long-term prognosis
- These patients be reassessed and discussed with the patient, next of kin, legal representative, or power of attorney at regular intervals.

Given the difficulty of giving weight to these recommendations, new admission policies have been developed for cancer patients, and full code, ICU trial, or palliative care in ICU will be discussed in more detail at a later point.

As a summary of what is external to the patients themselves, Table 1 shows the factors that have been seen to have a positive influence on the care of the oncology patient in our Units.

Admission Criteria

The criteria that the intensivist must assess to admit a patient into the unit should include:

- The true indication or need for management in the ICU
- Presence of a trained specialist in the field
- Prioritizing depending on the patient's condition
- Reason for admission
- Bed availability
- Objective vital data
- Patient prognosis
- Potential benefit of interventions performed on the patient

Table 1 Hospital organizational factors that improve care

Hospital organizational factors that improve care
A high-intensity ICU model characterized by the intensivist being responsible for day-to-day management of the patient in a closed ICU setting
ICU's relationship and collaboration with other services
Joint daily decision-making between critical care physicians, hematologists, and oncologists
Participation in medical rounds made by other specialists such as palliative care physicians or clinical pharmacologists
Drawing up protocols for routine care and procedures in intensive care as well as the provision of clinical guidelines
Strategies for the early detection of multiorganic dysfunction, either by means of early intervention teams, through alarms in clinical information systems, or with the help of rounds by intensive care physicians assessing the frail patients at the request of their treating physicians
Dissemination of the knowledge and facts about the cancer patients in triage for admission to hospital
Introducing early palliative care for critical ill cancer patients
Structure and equipment so as to offer the necessary care in the different admission policies: Full code, ICU trial, exceptional admissions, or palliative care in ICU

This is really what is done every day when patients are assessed. According to the beds available in the unit, the patient is assessed, taking into account his/her background, prognosis, acute condition, and whether or not his/her needs can be met in the ICU.

There are four pillars of assessment (Fig. 1) when it comes to determining whether to admit a cancer patient to the ICU from the patient's perspective.

In the following paragraphs, what factors within each of these pillars will be explained and how they can and should affect our decision when deciding to admit a cancer patient.

The Patient and Their Characteristics

The cancer patient presents some differentiating characteristics in comparison with other patients. This does not mean that different measures are taken to restrict their access to the ICU; moreover, because they are cancer patients, they should not have fewer opportunities for admission than others.

Among the characteristics **that should not influence** us when deciding on their admission are age, the presence of neutropenia, as well

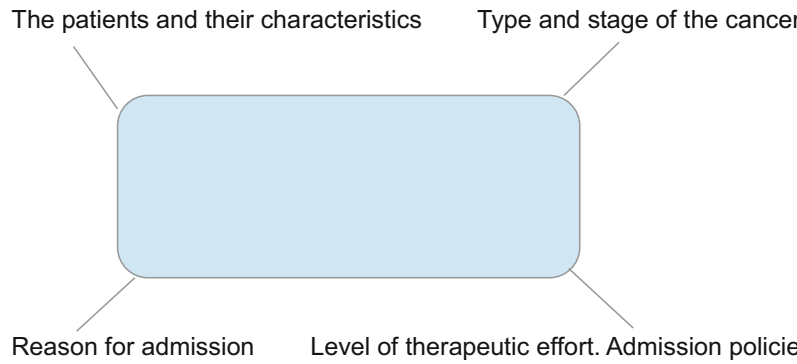

Fig. 1 Pillars of assessment

as hematological disease with autologous transplants.

It has already been demonstrated in numerous articles that access to intensive care units is not restricted for the elderly. Recommendation 2c of the SCCM guidelines is to assess the comorbidities of patients, their physical functional status, and the severity of the process coupled with their opinion rather than the chronological age in patients over the age of 80. Specifically in our patients, a review of Auclin et al. [22] found no difference in the subgroup of older cancer patients (75 +/− 6.7 years) with those who did not have tumor disease (33.6% vs. 32.6%).

Neutropenia in cancer patients is not a risk factor for them. Bouteloup et al. [23] in a systematic review of 6,054 cancer patients of whom 2,097 had neutropenia in studies between 2005 and 2015 found that neutropenia when adjusted for patient severity did not affect patient mortality.

Patients with blood disorders, who have undergone autologous bone marrow transplantation, due to the intensity of chemotherapy and the increased frequency of neutropenia and organ failure have typically presented slightly higher mortality rates; but advances in supportive care and ICU treatments have made it similar to that of any patient in general intensive care units today [24].

Among the factors that **marginally affect** their prognosis are admission severity scores (which actually tell us about the patient's multi-organ dysfunction) as well as excessive comorbidity.

All the clinical scoring commonly used in ICUs at admission (MPM, APACHE, or SAPS) overestimate the severity of the cancer patients' condition by considerably increasing the probability of having tumor disease [25]. For all these reasons, other more specific indices (HCT-CI or Cancer Mortality Model CMM) ([26, 53]) have been developed and are pending validation through multicenter trials. SOFA does appear to have a good discriminatory capacity to predict mortality rates in ICUs and hospitals of oncology patients admitted for medical reasons, rather than for surgical procedures, according to a review by Cárdenas-Turanzas et al. [27] of a population of 6,645 patients admitted to an oncology ICU. Aygencel et al. [28] found a SOFA value of 9 or higher in patients with solid tumors or 10 or higher in patients with hematological tumors as the highest mortality indicator in critical oncological patients. More important than the number of organ failures on admission of our patients is their response to treatment during the first few days of their stay in our units. The persistence or worsening of this multi-organ dysfunction is clearly associated with mortality in ICU. This is the basis of the ICU trial that will be discussed below.

Other factors, which should be taken into account, are their previous quality of life, their performance status, personal and family decisions regarding their decision to be admitted to the ICU, and the appearance of complications in an allogeneic transplant.

The patient's previous quality of life as measured by the performance status (PS) is a simple scale that assesses the patient's physical functionality and quality of life (Table 2). It is useful for predicting mortality in all critical patients and has been corroborated by numerous studies in critical cancer patients. A PS 3–4 is associated with an increase in ICU mortality of four to seven times in patients with a PS 0–2 [4]. Only those situations in which the deterioration of the patient's condition is due to a recent diagnosis of the tumor or a potentially reversible cause would be significantly improved with aggressive treatment.

Table 2 ECOG performance status

Grade	ECOG performance status Description
0	Fully active, able to carry out all pre-disease performance without restriction
1	Restricted in physically strenuous activity but ambulatory and able to carry out work of a light or sedentary nature
2	Ambulatory and capable of all self-care but unable to carry out any work activities. Up and about more than 50% of waking hours
3	Capable of only limited self-care, confined to bed or chair more than 50% of waking hours
4	Completely disabled. Cannot carry out any self-care. Totally confined to bed or chair
5	Dead

According to the 5th International Consensus Conference on Intensive Care, the decision to limit treatment in the ICU should be based on the principle of patient autonomy.

Because that only 5% of the patients admitted to our units have the capacity to make decisions about their illness intact [29], prior consensus between the patient, family members, and treating physicians is essential. When this does not occur, the patient receives more aggressive measures and usually loses the possibility of receiving quality palliative care. For all these reasons, it is essential to advance along the path of dynamic decision-making during the course of the disease [30]. The oncologist's continuous, immediate, and clear communication, the patient's functional status, as well as the therapeutic options at all times must be weighed against each other in order to clearly understand the transition from curative to palliative care. But we still find that even in cancer centers, many patients are not sure of the essential measures they need to take with their oncologists, such as non-resuscitation [31].

The need for intensive care admission for allogeneic transplant patients has decreased by 8% over the past two decades; mortality has also decreased from 80% in the 1990s to 60% today [32]. Although infections are common in these patients, the main cause of death is severe respiratory failure requiring mechanical ventilation of a noninfectious origin. In spite of the high mortality rate, admission is still recommended for its management, especially if complications appear in the immediate post-transplant period. But the appearance of multi-organ failure in these patients, especially in the midst of anti-graft disease, should prompt us to reconsider the decision to go ahead.

Tumor Type and Stage

Cancer patients are an extremely heterogeneous group of patients. There are many and very different types of tumors, each one of them with a different evolution according to its genetics and biology; with different answers for the same treatment depending on the evolutionary stage of the disease and even in each individual.

Intensivist cannot base the decision of admission to the ICU on the stage of the tumor. This has been inconsistently associated with increased mortality. Thus, while some studies showed that patients with stage IV or metastatic tumors were more likely to die in hospital [33, 34], other more recent studies with a greater number of patients ([22, 35]) did not find a link between disseminated disease and short-term outcomes (ICU and hospital mortality).

Provided there are therapeutic options, the failure of any treatment line should not be a reason to refuse admission [11]. Yes, tumor progression without treatment options is associated with poor prognosis.

The origin and histological classification of the tumor is not related to prognosis in the ICU, although it does influence long-term outcomes. Typically, hemato-oncological diseases have had worse outcomes than solid tumors, but these differences have been disappearing over the years in ICU and hospital mortality outcomes [36, 37]. However there are groups of patients in whom mortality has remained virtually unchanged and remains extremely high and whose admission must be considered; these bone marrow transplant patients with severe graft-versus-host disease (GVHD) do not respond to immunosuppressive therapy. Also, these are the patients who exhibit solid tumors with severe complications such as acute respiratory failure due to lymphangitis, meningeal carcinomatosis, and coma or when they infiltrate and produce spinal cord failure.

With regard to tumor disease, it is believed that the following indications (Table 3) are shown in and are usually accepted in any cancer center.

Reason for Admission

Each hospital has its own particular caseload regarding the reasons for admission of oncohematological patients to its ICUs; this will depend on whether we are in an oncology hospital, in a privately or publicly managed hospital, and the ratio of ICU beds to the patient reference population.

Table 3 Admission criteria from the perspective of the disease

Admission criteria from the perspective of the disease
Patients in complete remission
Newly diagnosed patients of less than 3 months and with a life expectancy of more than 6 months
Patient with failure of one or more treatment lines but with future options (transplant, clinical trial) without malignant involvement of vital organs
Patients with treatment toxicity, complications of this treatment or of procedures related to its process
Patients in clinical trials whose aggravation may be related to the treatment
Patients in whom it is essential to reduce tumor pressure, which is responsible for complications and organ failure. QT is safe in the ICU and its administration does not worsen the prognosis [11]

We will now look at the main reasons for admission to our units Soubani [9] and the advances and changes that have led to improved survival of clinical profiles (Table 4).

New Strategies of ICU Admission

There are four scenarios in which cancer patients have a place depending on all the variables previously analyzed (Fig. 2):

- *Full code management*: This would be treatment with curative intent and without restrictions, similar to any other critical care patient.
- I*CU trial*: An increasingly accepted admission policy that began with a study of hematological patients with respiratory failure by Lecuyer et al. [42]. All oncohematological patients (except bedridden patients, those who refused admission and palliative care patients) were admitted to the ICU for 3 days without restrictions in terms of techniques, treatments (including QT), and resources. It was observed that all patients who worsened in terms of their organ dysfunction (by measuring the SOFA) by day three of admission showed a clearly unfavorable development with those who improved in terms of their organ dysfunction by the third day of admission. All those patients who required mechanical ventilation, vasopressors, or dialysis after the third day died. This unrestricted ICU test is currently the path being followed in most intensive care units when faced with the admission of an oncology patient [43, 44]. Recent studies attempt to establish the optimal trial period such as Shrime et al. [45] concluding that trials of ICU care lasting 1–4 days may be sufficient in patients with poor-prognosis solid tumors, whereas patients with hematologic malignant neoplasms or less severe illness seem to benefit from longer trials of intensive care.
- *No ICU admission* and no intensive care treatment: No indication of admission or use of intensive care therapy such as renal clearance techniques or noninvasive ventilation.
- *ICU admission outside of routine indications*: Here there would be prophylactic admissions, exceptional admissions, as well as palliative care administration.

ICU Discharge

Related literature in the last few years is full of admission criteria, patient and disease characteristics, causes for admission, and its policies, but few articles evaluate the reasons, timing, and follow-up of ICU discharges, especially in relation to cancer patients.

A meta-analysis of Hosein et al. [46] on the discharge from ICU of almost two million patients found that, of every 100 patients discharged alive from ICU, between 4 and 6 are re-admitted and 3–7 die before being discharged again from hospital. This has led to the search for safety predictors in patients discharged from the ICUs, as well as to the enabling of discharge or follow-up policies that reduce these complications.

The discharge APACHE II score and hospital length of stay before ICU admission are significant independent factors in predicting post-ICU mortality and is superior to the admission APACHEII score in predicting early ICU readmission in surgical ICU patients.

On the other hand, seeing how the rapid response teams have demonstrated their

Table 4 Improvement areas depending cause of admission

Causes of admission (%)	Improvement areas
Postoperative elective or emergency 50–60%	Increased specialization in surgery, as well as in case management, and fast track recovery management
Severe sepsis and septic shock 16–18%	Early recognition of sepsis and rapid implementation of sepsis bundles Better understanding and management of multiorgan failure Use of biomarkers to diagnostic
Respiratory failure 10% Infectious Noninfectious: ARDS secondary to polytransfusion, underlying disease, treatment and/or toxicity of same	Early NIV may be harmful High-flow oxygen has demonstrated survival benefits compared to NIV [38, 39] Compared to BAL, noninvasive tests have the same diagnostic and therapeutic fields Do not delay mechanical ventilation if indicated Protective lung ventilation
Change in level of consciousness 5% Metabolic Sepsis Cerebral LOE versus bleeding Posterior reversible encephalopathy	Daily interruption of sedation New sedative agents Sedation based on analgesia
Oncological emergencies: 3% Tumor lysis syndrome (TLS) Superior vena cava syndrome (SVCS) Cardiac tamponade Airway obstruction Hypercalcemia	Early admission of cancer patients at risk of tumor lysis syndrome or renal failure has been shown to improve survival Use of ultrasound at the bedside
Bleeding from leakage, coagulopathy, thrombopenia 2%	The values of Hb without active bleeding are considered safe around 7 g/dl except in postoperative major surgery which should be greater than 9 g/dl [40] The dysfunction of platelet aggregation and the alteration of vascular integrity means that we should not look only at the number of platelets to indicate their transfusion
Concomitant medical processes: ischemic heart disease, COPD, PTE, liver failure, renal failure, etc. 2%	The increasing knowledge of the adverse effects of cancer treatments helps us to focus on the dysfunction of the affected organ
Administration of QT in fragile patients or patients with an allergy to QT 1%	Providing it in the safe environment of the ICU reduces complications and has better results. Associated sepsis or need for life support at the same time is not a contraindication to administer it [41]
PostRCP	Survival is <2% and ICU care after resuscitation may be considered futile
Multiple readmissions for organic dysfunction after ICU admission	Hospital mortality is multiplied by 11 and cancer treatment is not usually continued, so continued readmissions can be considered futile

usefulness in reducing the mortality of cancer patients in ICUs by detecting their organic dysfunction early, an attempt has been made to transfer this model to close monitoring by intensive care doctors, nurses, and respiratory specialists of those patients who are discharged from ICUs during the first 48–72 h. These Critical care transition programs have been widely assessed by Stelfox et al. [47]. After analyzing 32,234 patients over 10 years in eight hospitals, he has observed that, although there is a certain trend towards a decrease in readmissions in the patients followed by these teams compared to the control group (also described in the meta-analysis by Niven et al. for the NHS), a significant difference in mortality cannot be determined for both groups.

The SCCM in its guidelines on admission and discharge policy for ICUs recommends a series of

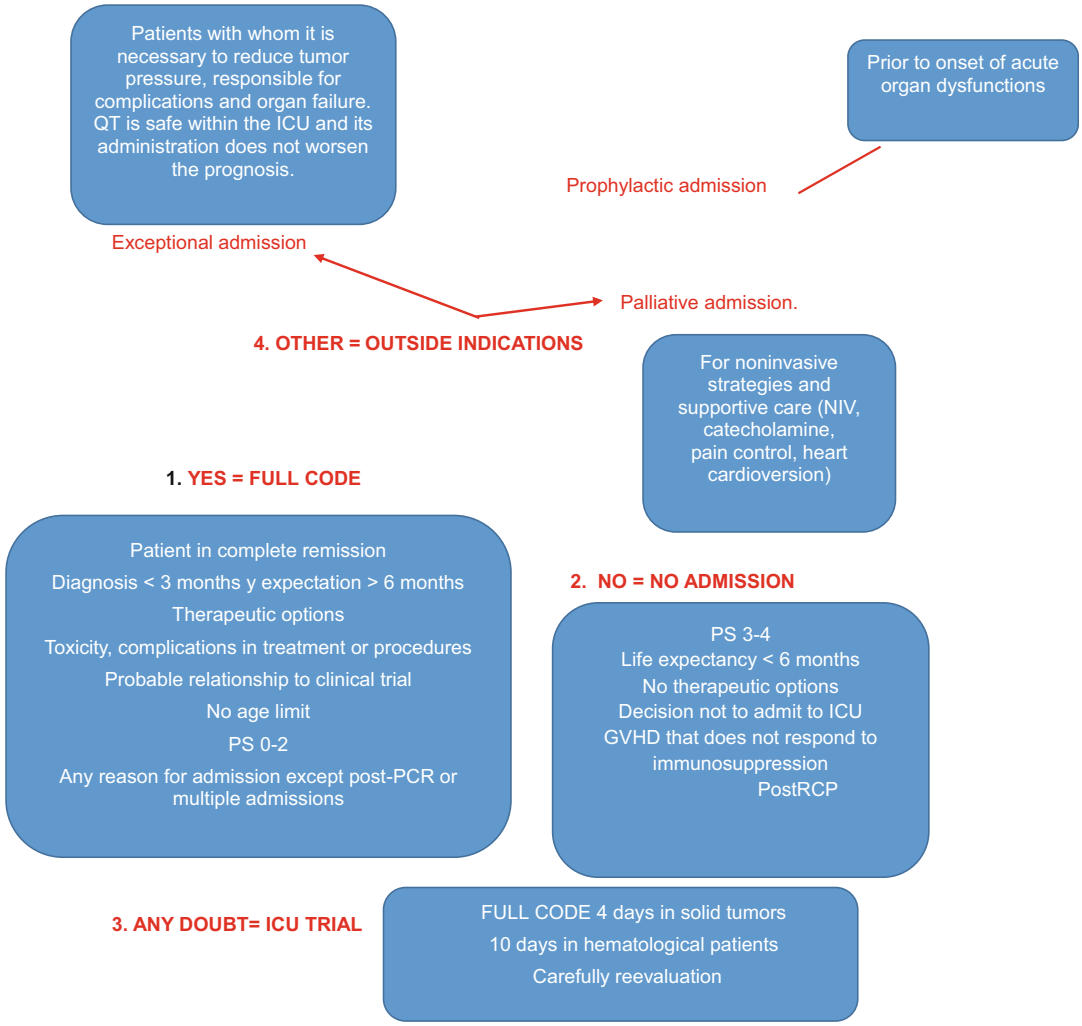

Fig. 2 Admission policies

actions, most of them lacking any compelling evidence, but which are widely accepted and usually carried out by the majority of intensive care physicians.

- Discharge patients when they are physiologically stable and do not require monitoring or their own intensive care treatment.
- Discharge patients at a lower level of acute care depending on patient disposition, prognosis, stability, or the need for patient interventions.
- Taking into account, as we discussed previously APACHE II at discharge, the rates as an aid in identifying those patients at high risk of deterioration following discharge from the ICU.
- Whenever possible, especially with frail patients, talk to the doctor receiving the patient to tell him/her about their progress, treatment, and management. This could reduce the frequency of readmissions.
- With level 2C, patients would not be discharged at night, hospital mortality has increased (OR1.31), but there is no difference between discharging them on weekdays and weekends.
- Also, with level 2C there would be the use of intermediate care units or long-stay hospitals

for those patients who are still fragile, either because of the severity of the disease, their multiple comorbidities, physiological instability, or because they still have the support of a vital organ at discharge.

Regarding the survival and quality of life outcomes of cancer patients, studies tend to focus on intra-ICU mortality, hospital mortality or mortality at 30–90 days. Such short results do not give us valid conclusions as to the actual benefits and overall cost-effectiveness of ICU care in cancer patients. Fifteen years ago, the one-year survival rate for cancer and hematological patients was 25% [48], whereas more recent studies place it between 18 and 64% [49].

In general, it seems to be shown that the long-term survival of cancer patients does not depend on the severity of the process or the time spent in the ICUs, but rather on the prognosis of the tumor disease [50].

Summary

The progressive increase in the incidence of cancer cases (mainly solids), the technological advance, the accumulated experience, and, above all, the better knowledge of the etiopathogenesis of the neoformative processes have sparked interest in this type of patients from all areas. The ICUs are not alien to this interest, seeing in these patients the possibilities that they did not see before, considering this group of patients in a similar way to another subgroup of severe diseases. But not everything goes, sensibly they have been developing guidelines of action or strategies against them according to the moment of the diagnosis and treatment options, with special attention to the moment in which they develop failure of some organ and evaluating each day this dysfunction. This careful monitoring within a multidisciplinary team, far from the usual loneliness of the intensivist, has brought the possibilities of survival in our units closer to that of any other type of seriously ill patient. Today we can say that no cancer patient should have fewer opportunities for treatment than another critical patient, always respecting personal autonomy.

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ICU Staffing, Models, and Outcomes

4

Karen Chen and Joseph L. Nates

Contents

Introduction 34
Open Versus Closed ICUs 34
Leapfrog Group Standards 35
Staffing Models 35
Associated Costs in Various Models 37
Associated Outcomes with 24-Hour In-house Intensivists 38
Patient Ratios 38
Burnout Syndrome in Intensivists 39
Summary 40
References 41

Abstract

As one of the most expensive resources in the healthcare system, the intensive care units (ICUs) are closely monitored for appropriate utilization and adequate staffing. The latter, considered one of the most challenging and controversial, is extensively discussed in this chapter. Optimal staffing of an ICU is highly dependent on multiple factors including, but not limited to availability of trained personnel, educational trainees, acuity of patients, size of ICU, and economic constraints. Therefore, staffing models need to be carefully selected and implemented based on the local setting. The key commodity in ICU staffing is the availability of specialty trained personnel, namely the intensivists and ICU nurses. Thus, in order to efficiently staff the ICU, attracting and retaining the intensivists, requires creative models which may focus on time off and lifestyle factors. The benefits of open versus closed units, high-intensity versus low-intensity models, and the classic academic and 24-h models are explored to provide the reader with a clear understanding of the benefits of these complex options and associated outcomes.

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Introduction

Intensive care is one of the most expensive aspects of health care in the United States. By some estimates, it has exceeded 108 billion dollars in 2010 [1]. Although ICU beds usually comprise approximately only 10% of the hospital beds, its associated costs are around 30% of the hospital budget [2]. As the population ages, associated healthcare costs and ICU utilization will increase. Thus, ICU staffing with its impact on outcomes and costs will need to be clearly evaluated.

The patients in the ICU utilize specially trained personnel in order to implement effective processes and perform specialized procedures in order to improve mortality and length of stay (LOS) [2]. Due to the limitation of resources along with its associated costs, staffing of the ICU in the United States varies widely throughout the nation.

The sentinel paper affecting ICU physician staffing was published in 2002 by Pronovost et al. [2]. In this landmark study, critical care staffing came into the forefront. The ICU groups were classified into high-intensity (mandatory intensivist consultation or closed ICU, where all care was directed by the intensivists) versus low-intensity (no intensivist involvement or elective intensivist consultation). In this study, high-intensity ICU physician staffing reduced hospital and ICU mortality as well as hospital and ICU LOS [2]. At the time of the study, it was estimated that only about one third of the ICUs in the United States utilized a high-intensity staffing model [3]. This contrasts to the predominantly closed ICU staffing model utilized throughout Europe and Australia.

Open Versus Closed ICUs

A basic premise in staffing a critical care unit first depends on a closed versus an open ICU system. In a closed ICU, only critical care staff admits and manages the critically ill patient. The primary service becomes a consultant on these patients. All decisions in a closed ICU are made by the critical care team, taking into consideration the advice as provided by the consultants. All issues are addressed by the critical care team and admission to and discharge from the ICU is determined by the critical care staff. In terms of ICU staffing, this is usually the most labor intensive as it requires a dedicated ICU team to provide consistent care and efficiently triage patients in and out of the ICU around the clock. This is the predominant staffing model utilized in Europe and in Australia. Although it is not widely implemented in the United States, when it is used, it is most commonly found in major academic medical centers due to the significant amount of resources required.

On the other hand, an open ICU allows anyone with hospital admission privileges to admit and treat with or without the involvement of the ICU team. In essence, ICU admission, management, and subsequent discharge are at the discretion of the admitting physician. Essentially, the ICU provides nursing care, monitoring, and certain therapies that may be limited to ICU utilization (i.e., vasopressors, invasive monitoring) without requiring ICU attending consultation or input.

Many current ICU models utilize a system which is a hybrid between the two. These ICUs are considered either semi-closed or semi-open. By definition, the semi-closed ICU is one in which anyone can admit a patient to the ICU, but the critical care team is automatically consulted and comanages all patients. Whereas in the semi-open unit, anyone can admit a patient to the ICU and the critical care team is consulted but not all patients are comanaged.

Thus utilizing these definitions, the closed and semi-closed ICUs would be considered

high-intensity staffing versus the open and semi-open ICUs which would be considered the low-intensity staffing as defined by the Pronovost study in JAMA [4].

Leapfrog Group Standards

New ICU staffing models were proposed after the Institute of Medicine published a report in 1999 showing a high rate of preventable medical errors [37]. In addition, it was noted many ICUs had an unacceptably high rate of mortality with an exorbitant cost structure. Due to this financial burden, health care purchasers became involved [5]. Most notably, the Leapfrog Group, a consortium representing large employers who are purchasers of health care, proposed regulatory guidelines in ICU physician staffing (IPS) to improve the quality of care and with associated cost containment thus increasing value in the healthcare system [6].

As noted in the Leapfrog-ICU Physician Staffing (IPS) factsheet, over 200,000 patients die in US ICUs each year [7]. Unfortunately, the quality varies widely across hospitals [8]. Thus, in order to improve the quality of care, certain requirements were placed on IPS by the Leapfrog Group. The two major components affecting the quality of care include whether "intensivists" are providing care and how the staff is organized in the ICU (open vs. closed ICUs) [6].

By the Leapfrog IPS standard, the definition of "intensivists" must satisfy one of the following: board-certified physicians who are additionally certified in the subspecialty of critical care medicine or physicians who are board-certified in medicine, anesthesiology, pediatrics, emergency medicine, or surgery who have completed training prior to the availability of a subspecialty certification in critical care and provide at least 6 weeks of full-time ICU care each year [6]. Neurointensivists are an approved alternative to intensivists as well.

The Leapfrog IPS safety standard requires intensivists who are present during daytime hours and provide clinical care exclusively in the ICU and when not present on-site or via telemedicine, returns notification alerts at least 95% of the time within 5 min, and arranges for a physician, physician assistant, nurse practitioner, or a FCCS-certified nurse to reach ICU patients within 5 min [6].

Many challenges have come out of meeting the Leapfrog IPS standards. Some of these include: some nonintensivist physicians unwilling to relinquish care to intensivists, lack of intensivists due to shortage of available personnel, decreased sizes of training programs in critical care, many board-certified intensivists choose not to work in the ICU [9], and small hospitals may lack the economies of scale to support full-time intensivists thus necessitating consolidation of these units or introduction of telemedicine into these units [6].

Various models need to incentivize the commodity, which currently is the skilled labor force, which namely consists of the critical care intensivist and/or physician extenders. As noted by studies published by the major professional societies representing critical care, namely SCCM and ATS, these shortfalls will continue to worsen as the need for critical care services increases as the workforce cannot keep up with these demands and provide due to multiple reasons [10, 11].

A report to Congress by Duke also noted this shortfall to continue through 2020 though not predicted to be at the same pace as per the methodology of the COMPACCS study [12].

Staffing Models

As there has been tremendous growth in the number, size, and occupancy of ICU beds, but not a commensurate growth in critical care physicians, there is a workforce shortage to staff these ICUs [13]. Multiple issues have led to the shortfall in the workforce. This includes lack of critical care intensivists, lack of resident and fellow trainees due to restricted work hours, and lack of critical

care nursing staff. In addition, the cost of care in an ICU along with decreased reimbursements as well as the 24–7 coverage needed, whether in-house or readily available, adds an additional layer of complexity to ICU staffing. Although "society invests billions in the development of new drugs and technologies but comparatively little in the fidelity of health care, that is, improving systems to ensure delivery of care to all patients in need" [14]. Due to the various factors as outlined earlier, novel models for staffing critical care units will need to be utilized in order to deliver effective care. This chapter will focus on the staffing of the critical care unit as it applies to intensivists, house staff, and other licensed allied providers. It will not discuss nurse staffing for the ICU.

In order to bridge the gap, various models to staff the ICUs have been utilized. There are advantages and disadvantages to each of these models, which are described in further below.

Historically, the academic model with 24-h coverage has been the default model in most critical care units. This model traditionally utilizes residents, fellows, and medical students led by an attending physician. Challenges in staffing this model include poor work–life balance, limited availability of trainees due to duty hour and length of shift restrictions, as well as limited attending faculty available to work nights, weekends, and holidays. This strictly academic in-house intensivist model is resource heavy and extremely costly. A recent meta-analysis has shown that in-house nighttime intensivist staffing has not resulted in improved patient outcomes [15]. In addition, in many institutions this has become nonviable due to lack of residents and fellows or due to the duty hour restrictions on them. Furthermore, as critical care is a subspecialty with all providers first having primary training in surgery, anesthesiology, pulmonary, internal or emergency medicine, many trainees choose or resort back to their primary specialties due to the better quality of life or financial incentives offered in the primary specialty. Thus, the available resource pool to staff this model is highly restrictive.

A variation of this model would be the modified academic model, which may provide 24-h in-house coverage with fundamentals of critical care support (FCCS) certified providers in-house with backup from an attending physician available 24 h a day. This has been typically utilized due to the limited availability of trainees to fill this role in house 24 h a day. In this model, instead of or in addition to the trainees, advanced practice providers (APPs) such as physician assistants (PA) or advanced practice registered nurses who are FCCS certified supervised by an attending physician provide care in the ICU. Many ICUs throughout the nation are using advanced practice providers (APPs) including nurse practitioner (NP) and PAs to cover the shortfall in meeting ICU workforce demands [16, 17]. A comprehensive review of the literature by Kleinpell et al. concluded that the literature supports the value of APPs in patient management, reinforcement of practice guidelines, education of patients, families and ICU staff as well as quality and research initiatives in the acute and critical care setting. Research studies that address the utilization of the advanced practice provider in the acute care setting as it relates to patient outcomes still need to be conducted. In addition, successful models of multidisciplinary ICU care utilizing the advanced practice providers need to be widely distributed to optimally utilize these resources for ICU staffing [18]. In this model, the APPs are trained and maintain competency in certain frequently performed procedures such as ventilator management, central and arterial line placements, and possibly some unit-specific procedures, such as lumbar punctures in neurointensive care units. Some high-risk procedures such as intubations or chest tube placement need to have in-house support, often by other specialists namely anesthesiologists or emergency physicians.

Further modification of this model may include in-house "moonlighting physician" supervision of the advance practice providers. For instance, pulmonary critical care fellows or oncology fellows, who are board certified in internal medicine with adequate ICU experience, could be utilized to work in conjunction and supervise these advanced practice providers. In this model, the attending faculty intensivist remains available for emergency phone

consultation. The major drawback in this model is the lack of consistency and additional costs incurred in the employment of these "moonlighting physicians." Also, if the scheduling of these moonlighters is on a voluntary basis, there may be holes in the schedules or last minute vacancies. Thus, contingency plans must be made in order to fulfill patient care needs.

Due to the difficulty attracting and retaining intensivists, there has been a shortage in these qualified specialists. Thus, other models have been explored and utilized. The following models are not compliant with Leapfrog standards for IPS.

One staffing model which has grown in popularity recently (though usually not compliant with Leapfrog standards) due to the shortfall of intensivists is one in which advanced practice providers fully provide the care in the ICU. In this model, a team of advanced practice providers provide 24-h in-house coverage of the patients. There are a few abstracts which have demonstrated that this model does not have any worse outcomes than the traditional academic (attending and resident/fellow) or modified academic (attending and APPs) models. The advantages to this model is that there is no need for an intensivist, who is in short supply, and is much more easily accomplished as there has been a tremendous growth in programs training APPs with critical care expertise. In addition, this care model is significantly less costly.

Another model consists of utilizing hospitalists to staff or also cover the ICU. In a study published more than a decade, 83% of hospitalists provided care in the ICU [19]. Furthermore, a study conducted in medical ICUs in a community hospital published in 2012 demonstrated similar outcomes between an ICU staffed predominantly with hospitalists and a companion ICU with an intensivist model [20]. Therefore, more collaboration between hospitalists and intensivists will likely continue to occur and the results of these endeavors are still to be determined.

Other models which have been utilized include an intensivist staffing during the day with FCCS trained nurses, or a full open ICU where anyone can admit to the ICU, consult an intensivist if and when desired, and then be managed by the bedside registered nurse and/or "moonlighting coverage" physician, of various specialty training. Oftentimes, these physicians may be house staff or trainees from nearby training programs. Patient outcomes in these models have not been studied against the Leapfrog IPS standards. As healthcare evolves, further exploration into newer staffing models may be necessary due to ongoing skilled personnel shortages.

With improvements in technology, ICU telemedicine plays a role in improving outcomes while limiting costs by more effective resource utilization. In a multicenter case-control study published in 2016, ICU telemedicine facilities had a small but statistically significant relative overall mortality reduction, with large-volume urban setting hospitals achieving the largest decrease in mortality [21].

In conclusion, APPs and hospitalists are likely to contribute significantly to ICU staffing in the future. Of utmost importance, is ensuring their adequate critical care training, establishing competency, and credentialing, in order to effectively collaborate with the intensivists in providing multidisciplinary care [17]. These providers should be considered complementary, not a substitute, to the intensivist.

Associated Costs in Various Models

Although costs vary, personnel compensation costs comprise a large proportion of critical care costs. In the classic academic model, the attending intensivist's, residents', and fellows' compensation must be calculated. Although actual dollar values are not compared, the relative costs based on current market compensation of each of these individual roles will be utilized. For example, attending intensivists cost more than hospitalists, who cost significantly more than advanced practice providers (physician assistants and nurse practitioners), who cost more than fellows and residents. In addition, what is the staffing ratio necessary to provide optimal care in this model? Another question, especially for attending physicians, is the differential for night coverage

for which one must be compensated either through time or money. Does the additional cost of delivery of care in this model improve the patient outcomes? Does patient satisfaction and experience improve by having the availability of an attending 24 h a day in the ICU? These questions will be analyzed in this chapter.

In the modified academic model, the substitution of APPs for the residents/fellows slightly increases the costs as these salaries in the current market environment are higher than the cost of house staff. On the other hand, could the APPs require less supervision and manage certain ICU patients independently and thus bill individually, therefore offsetting the cost of their salaries?

In a fully open model, often utilizing the private practice model, the costs of care in these patients are variable. The patient is billed by the consulting intensivist who gives recommendations and is available by telephone for questions. The intensivists usually do not take over the care of these patients and ensure that the recommended treatment is carried out in a timely fashion, trying to shorten the length of stay in these critically ill patients.

As technology has improved, telemedicine has become a viable alternative. Present day, the cost of telemedicine varies from $50,000 to 123,000 per day [22]. In the implementation of this model, the cost of staffing the telemedicine with qualified personnel is a large component of the costs. In addition, this does not account for the costs incurred for the on-site personnel, which is necessary to perform procedures or provide physical contact/examination of the patients.

Associated Outcomes with 24-Hour In-house Intensivists

Initially, in the classic Pronovost study as utilized in the Leapfrog IPS recommendations, high-intensity ICU physician staffing improves outcomes [4]. Thus, these results were extrapolated to a 24-h in-house intensivists model which significantly increased costs. Unfortunately, most studies with Mandatory 24-h staffing by intensivists did not affect ICU or hospital mortality [15, 17].

Although initially in 2003, SCCM and Leapfrog Group endorsed a 24-h intensivist staffing model [23]; the economic constraints and limitations of resources may not justify this. In addition, further studies did not show a mortality or hospital or ICU LOS benefit in a 24-h intensivist model [15, 17]. Wilcox et al. in 2013 concluded in a systematic review and meta-analysis that "High-intensity staffing is associated with reduced ICU and hospital mortality. Within a high-intensity model, 24-h in-hospital intensivist coverage did not reduce hospital, or ICU, mortality" [24]. The 24-h intensivist model had more benefit in surgical or mixed medical-surgical ICUs versus medical ICUs [24]. In addition, a recent ATS systematic review and meta-analysis concluded that nighttime intensivist staffing is not associated with ICU patient mortality [15].

Patient Ratios

There are multiple scholarly articles that discuss the negative impact of poor nurse to patient ratios but as previously stated this will not be covered in this chapter. Unfortunately, there is less evidence for optimal staffing ratios for intensivist to patient.

Matching healthcare personnel resources with patient acuity and needs is essential to maintain safe care in ICUs. Adequate patient-to-nurse (P/N) and patient-to-physician (P/P) ratios may be associated with higher survival rates and a lower risk of failure to rescue [25]. However, the optimal ratio, or the level above which outcomes worsen, have not been established. In addition, these ratios have been determined by panels of experts and not scientifically validated [17].

As noted in the Leapfrog IPS factsheet, outcomes are better in ICUs staffed by intensivists. Unfortunately, the optimal intensivist–patient ratio is not specified and unknown [26]. The intensivist–patient ratio is likely to be influenced by several factors including, but not limited to the patients' acute severity of

illness and comorbidities, other available physician specialists, and other allied healthcare professional support as well as nonhuman resources such as medical equipment or information technology [17, 26].

A recent statement from the society of critical care medicine on ICU staffing in closed ICUs concluded that "while advocating a specific maximum number of patients cared for is unrealistic, an approach that considers the following principles is essential: (1) proper staffing impacts patient care; (2) large caseloads should not preclude rounding in a timely fashion; (3) staffing decisions should factor surge capacity and nondirect patient care activities; (4) institutions should regularly reassess their staffing; (5) high staff turnover or decreases in quality-of-care indicators in an ICU may be markers of overload; (6) telemedicine, advanced practice professionals, or nonintensivist medical staff may be useful to alleviate overburdening the intensivist, but should be evaluated using rigorous methods; (7) in teaching institutions, feedback from faculty and trainees should be sought to understand the implications of potential understaffing on medical education; and (8) in academic medical ICUs, there is evidence that intensivist/patient ratios less favorable than 1:14 negatively impact education, staff well-being, and patient care" [17]. In this Task Force Statement, there is a proposed intensivist–patient ratio staffing tool as noted in Appendix 1 in this paper. This roughly calculates the intensivist's direct patient care time taking into account the number of patients and acuity of illness as well as nondirect patient care activities, which may include administrative duties, family meetings, teaching responsibilities, sign out, or curbside consultations [17].

Other supporting evidence includes a multicenter study done over 1 year that demonstrated an associated risk of mortality in nurse to patient ratio of greater than 1: 2.5 and a provider to patient ratio of greater than 1: 14. Interestingly, the times associated with nursing shortage was scattered but more commonly on weekends, and for intensivist's nighttime hours. Provider ratios were as low as 3.6 patients per physician during the day versus 8.5 during the night [27].

In conclusion, a high-intensity model where intensivists manage patients either during the day or at night improves outcomes but the 24-h intensivist model does not show additional benefit in outcomes but does incur additional costs. Adequate management with performance improvement processes and structured rounds with implementation of daily care plans improves outcomes [28].

An official American Thoracic Society systematic review of current literature and meta-analysis, published in 2017, suggested that nighttime intensivist staffing is not associated with reduced ICU patient mortality [15]. In addition, minimal or no difference was noted in the ICU or hospital length of stay. Other outcomes and alternative staffing models should be evaluated to further guide staffing decisions [15].

These models included use of residents, fellows, nurse practitioners, or physician assistants. It included general or specialty ICUs as well as academic or community settings [15].

Burnout Syndrome in Intensivists

In a 2007 study, a high level of burnout among intensivists was noted. The results showed approximately one-half of respondents showed professional burnout [29]. A major challenge in ICU staffing needs a balance between continuity of care for patient care versus avoidance of burnout by allowing for uninterrupted time off clinically. Geva et al. utilized a computer simulation model to create a shared service schedule to best balance these opposing factors [30].

Working in a stressful workplace, especially in an environment like the ICU, precipitates burnout in the workforce [31]. In this systematic review, the following factors were associated with burnout: age, sex, marital status, personality traits, work experience in an ICU, work environment, workload and shift work, ethical issues, and end-of-life decision-making. Of note, younger age, male, single and childless, and those who work night shifts and longer than 36 h shifts as well as frequent end-of-life decision-making including decision to withdraw or

withhold life support were positively correlated with burnout [31].

Also, patient-centric care has become a driving force impacting payment models. Thus, patient preferences must also be factored into the ICU staffing model as this affects reimbursement.

Most staffing model research has focused on patient-related outcomes; as a result, little is known about the consequences of work schedules in intensive care on intensivists themselves. In some studies, there is no patient outcome differences in continuous intensivist scheduling versus cross coverage by intensivists for the weekend, but in the second scenario providers showed less burnout and improved work–life balance [32].

Due to the shortage of intensivists, other models utilizing APPs or other specialists such as hospitalists or family practice physicians will need to be studied for its effects on outcomes, costs, and overall value in health care as it pertains to ICU staffing. Furthermore, hospital administration and leadership need to be engaged to provide work environments that better support intensivists and critical care staff [33].

Summary

As advocated by the Leapfrog Group based on the initial study by Pronovost, daytime intensivists staffing has been associated with improved outcomes for patients admitted to the intensive care units [4]. This was further extrapolated by experts to extend 24-h around-the-clock care by an in-house intensivist in the ICU in an attempt to improve outcomes. This was an expensive endeavor due to the costs and shortage of intensivists. In addition, depending on the daytime staffing model this did not necessarily improve outcomes and incurred additional costs [15, 17].

The results showed that In ICUs with optional consultation with an intensivist, nighttime intensivist staffing was associated with a reduction in risk-adjusted in-hospital mortality. This may be due to more timely resuscitation or less medical errors. In ICUs with high-intensity daytime staffing defined as those which mandated an intensivist consultation or transfer of care to the intensivist, nighttime intensivist staffing conferred no benefit with respect to risk-adjusted in-hospital mortality [34]. Furthermore, a randomized study done at a large academic medical center published in 2013 in the NEJM by Kerlin showed no improvement of in-hospital intensivists on ICU or hospital mortality or length of stay [35]. Further studies, as noted by the Checkley study group, states that a 24-h staffing model by intensivists or a closed ICU does not improve ICU patient mortality [28].

Is there a difference in outcomes for the surgical patient population? This question was explored by Van del Wilden et al. They published a study in the surgical ICU population that showed no difference of the addition of an in-house intensivist on ICU or hospital mortality, ventilation days, complications, or readmission rates [36]. The addition of an in-house nighttime intensivist did decrease utilization of blood products and imaging studies, but it increased relative value units per full time equivalent (RVU/FTE) as the intensivists increased billing when present on-site [36]. Thus, based on the value equation of outcome–cost, overall health care value may be decreased in this model.

Optimal staffing of an ICU is highly dependent on multiple factors including, but not limited to availability of trained personnel, educational trainees, acuity of patients, size of ICU, and economic constraints. Therefore, staffing models need to be carefully selected and implemented based on the local setting. In addition, modifications may need to be made as these factors frequently change. The key commodity in ICU staffing is the availability of specialty trained personnel, namely the intensivists and ICU nurses. Thus, in order to efficiently staff the ICU, attracting and retaining the intensivist requires creative models which may focus on time off and lifestyle factors. These may also vary depending on the locale of the ICU and individual characteristics of the members of the group. Striking a balance between the needs of the ICU

staffing model and the intensivists' lifestyle with avoidance of burnout is paramount to success.

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Multidisciplinary Care of Critically Ill Cancer Patients

5

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Contents

Introduction 44

Nursing 44
Reasons for ICU Admission 45
Complications of the Oncologic Critical Care Patient 45
Compassion Fatigue 46

Nutrition 47
Nutrition Screening and Assessment 48
Malnutrition Interventions 49
Feeding Tube Placement in the Setting of Thrombocytopenia 50

Physical and Occupational Therapy 51
Early Mobility in the ICU 51

Patient Support in the Oncologic ICU 52
Patient Support 52
Routine ICU Care 53

Social Work and Patient Advocacy 54
Role of the Social Worker in the Intensive Care Unit 54
Social Worker Training 55
Activities and Barriers 55
Role of the Patient Advocate in the Intensive Care Unit 55
Patient Advocate Training 56

Chaplaincy 57
History of the Chaplain 57
Professional Training 57
Role of the Chaplain 58
Assessment Tools 58
Outcomes and Efficacy of Chaplaincy 59

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Conclusion 60
References 60

Abstract

Critically ill cancer patients have complex physical and emotional needs that are best met by utilizing a multidisciplinary care approach. Physicians, advanced practice providers, nurses, clinical pharmacists, dieticians, physical therapists, occupational therapists, patient advocates, social workers, and chaplains are essential members of the multidisciplinary team working together to achieve a patient-centered approach when caring cancer patients in the intensive care unit (ICU). This chapter focuses on six different areas of the multidisciplinary team and discusses how each group is utilized to support the critically ill cancer patient. Oncologic considerations and challenges in regard to nursing, nutrition, physical and occupational therapy, patient support, advocacy and social work, and chaplaincy are thoroughly reviewed in relation to the critically ill oncologic patient.

Keywords

Intensive care unit · Critical care · Oncology nurse · Compassion fatigue · Enteral nutrition · Parenteral nutrition · Malnutrition · Nutrition screening · Nutrition assessment · Physical therapy · Occupational therapy · Mobility · Acquired weakness · Delirium · Early mobility · Patient support · Chaplain · Chaplaincy · Spiritual care · Communication · Advocacy · Patient advocate · Social worker

Introduction

Care of critically ill patients in general is complex. The addition of cancer, immunocompromised systems, bleeding tendencies, and therapy-related organ failure makes for a challenging patient population. The best approach to care for both critically ill patients and those with cancer involves a multidisciplinary care team consisting of physicians, advanced practice providers (APPs), nurses, respiratory therapists, and clinical pharmacists. In addition to these core team members, dieticians or nutritionists, social workers, patient advocates, physical therapists, occupational therapists, and chaplains can provide invaluable support and expertise that improves the overall care and satisfaction of the patient and their family members. Studies have also shown that using a multidisciplinary team approach is associated with decreased mortality in clinical ICU patients [32]. Working together, each member of the team provides their expertise and suggestion for the care of the patient, and the team leader, typically the physician, finalizes the patient's plan of care. Once the plan of care is established, each member carries out their part. By recognizing and addressing both physical and emotional needs of the patient, the team is providing holistic care that results in improved patient satisfaction and outcomes. This chapter will discuss some of the unique roles and functions of various members of the multidisciplinary care team and how their actions can benefit the outcome of critically ill cancer patients. It will discuss barriers faced in caring for this complicated patient population and strategies to help overcome these difficulties. These techniques can be applied not only to critically ill cancer patients, but also to critically ill patients without cancer as well as complex patients who may be hospitalized but not necessarily require intensive care unit (ICU) care.

Nursing

Nurses in oncologic critical care settings are specifically trained to care for patients with various kinds of cancer throughout all stages of the disease process. Oncology nurses must learn specific skills beyond that required of a basic nursing program, including chemotherapy administration,

immunosuppression and chemotherapy side effects, and complications of chemotherapy, radiation, and investigational treatments. Many oncology nurses undergo rigorous testing to acquire oncology-specific certification through national cancer nursing organizations such as the Oncology Nursing Certification Corporation (ONCC), who offers many different cancer-specific certifications including OCN (Oncology Certified Nurse), AOCNP (Advanced Oncology Certified Nurse Practitioner), AOCN (Advanced Oncology Certified Nurse), and more [43]. Oncology certification ensures that the nurse has met minimum standards to provide safe effective care to the oncology patient. In addition to oncology and chemotherapy administration certification, nurses can undergo testing to receive specialized critical care certification. Although not required to work in any ICU, critical care certification through a national critical care nursing body is highly recommended for all ICU nurses, as it attests to the nurse's ability to provide proficient care for the critically ill patient. The American Association of Critical Care Nurses (AACN) offers a nationally recognized critical care specialty certification, the CCRN, which identifies nurses who have demonstrated mastery in the field of critical care nursing. By undergoing certification, nurses show their commitment to delivering high-quality expert care to the critically ill cancer patient.

Reasons for ICU Admission

Cancer patients are at risk for a multitude of complications including many that are not related to their malignancy. Studies have shown that roughly 5% of patients with solid tumors and 15% of patients with hematologic malignancies require ICU admission during the early phases of their illness [47, 48]. The retrospective observational study conducted by Puxty et al. [47] found that of 118,541 patients with solid malignancies, 14.1% of them died in the ICU and 24.6% of them died during their hospital stay. In a study performed by Pene et al. [46], patients with malignancies admitted to the ICU with septic shock had 30 day-mortality rates of 55.5% between 1998 and 2000, which had actually improved when compared to 79.4% between 1995 and 1997. Because of this improvement, various adjuvant therapies for both septic shock and general ICU care, which resulted to form the basis of recommendations of the Surviving Sepsis Campaign. However, with such high death rates and concern for lack of resources, practitioners should be diligent in their ICU admission criteria particularly when the cancer patient is considered end-stage or there are no further treatment therapy options.

It is well-known that immunosuppressed cancer patients are at risk for requiring higher level of care and interventions that can only be performed in an ICU. Some common examples of reasons for ICU admission include drug reaction, infectious complications after immunotherapy or chemotherapy, organ dysfunction due to the physical size or location of a tumor, post-stem cell transplantation complications, tumor lysis syndrome, hyperleukocytosis, thrombotic events, and severe electrolyte abnormalities [49]. The top reasons for ICU admission of the cancer patient have consistently been respiratory failure and sepsis [49]. Nurses caring for critically ill oncology patients must familiarize themselves with the expert treatment of the most commonly seen ICU admission diagnoses. The ICU nurse is at the bedside more frequently than the clinical provider, thus it is the nurse's responsibility to promptly recognize worsening of the patient's status and intervene as needed. Oncology critical care nurses should know common side effects and complications of frequently used chemotherapies and immunotherapies administered in their institution as well as common solid and liquid tumor complications. Table 1 identifies common causes of ICU admission that the oncology nurse must be aware of and competent to manage.

Complications of the Oncologic Critical Care Patient

Patients with cancer who have undergone chemotherapy or immunotherapy are at increased risk of

Table 1 Common reasons for ICU admission of the cancer patient

Admission reason	Example
Infection	Pneumonia, sepsis, cellulitis, abscess
Oncologic emergencies	Superior vena cava syndrome, tumor lysis syndrome, hypercalcemia, pulmonary embolism, gastrointestinal bleed, disseminated intravascular coagulation (DIC), severe mucositis
Acute respiratory failure	Transfusion-related acute lung injury (TRALI), transfusion-associated circulatory overload (TACO), pneumonitis, diffuse alveolar hemorrhage, malignant pleural effusion, acute respiratory distress syndrome (ARDS), flash pulmonary edema
Surgical complications	Post-op monitoring, bleeding complications, hemodynamic instability, multistage surgeries
Adverse drug reactions	Anaphylaxis, cytokine release syndrome, all-trans retinoic acid (ATRA) syndrome, thrombotic microangiopathy
Neurologic complications	Seizures, posterior reversible encephalopathy syndrome (PRES), altered mental status, metabolic encephalopathy, neurotoxicity
Cardiovascular complications	Myocardial infarction, congestive heart failure, arrhythmias, pulmonary thromboembolism, hypotension
Stem cell transplant complications	Graft-versus-host-disease (GVHD), organ damage

Adapted from Shimabukuro-Vornhagen et al. [53]

decompensation due to infection, organ failure, and decreased overall strength. Nurses caring for cancer patients in the critical care setting must be aware of common complications and adverse reactions specific to this patient population. They should be able to detect early signs of organ dysfunction or treatment toxicity and promptly notify the appropriate provider to help manage these complications. Cancer patients are specifically at increased risk of infection, sepsis, and respiratory failure. Many patients with malignancy will be at risk for either excessive bleeding or clotting, or both. Patients with hematologic malignancies such as acute myeloid leukemia may require frequent blood product transfusions and these patients should be monitored closely for transfusion reaction and volume overload. Care must also be taken to reduce the risk of nosocomial infection in the immunocompromised patient; thus nurses and other providers entering the room of an ICU patient, particularly those who are neutropenic, should strictly adhere to hand hygiene practices.

Nurses administering chemotherapy are specifically trained in the safe handling of such medications and how to handle chemotherapy spills. Hospitals have customized protocols regarding cleanup of hazardous medications, depending on the size of the spill. Oncology nurses are responsible for protecting not only themselves but also those around them from the harmful effects of chemotherapy. Chemotherapy and immunotherapy safety administration training is typically required upon hiring and renewed annually to provide a safe environment for these harmful medications.

The ICU mortality rate of cancer patients remains high and many patients and their families will prompt discussions regarding end-of-life with the bedside nurse, since they typically spend the most time throughout the day attending to the patient. Oncology critical care nurses should be prepared to discuss death and dying with their patients and their family members. Nurses can seek out educational opportunities within their institution or online to better equip themselves with the tools needed to empathetically and effectively discuss the dying process.

Compassion Fatigue

Working in the clinical field can be emotionally draining, particularly in the case of oncology patients, as a moderate percentage of those encountered in the ICU are in the terminal stages of cancer. One study has shown the mortality rate of cancer patients admitted to the ICU to be 46.6%