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Geriatric Anesthesiology

Third Edition

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Editors
J.G. Reves
Department of Anesthesia and Perioperative Medicine
Medical University of South Carolina
Charleston, SC, USA

Julie R. McSwain
Department of Anesthesia and Perioperative Medicine
Medical University of South Carolina
Department of Anesthesiology
Charleston, SC, USA

Sheila Ryan Barnett
Department of Anesthesia, Critical Care and Pain Medicine
Beth Israel Deaconess Medical Center
Harvard Medical School
Boston, MA, USA

G. Alec Rooke
Department of Anesthesiology and Pain Medicine
University of Washington
Seattle, WA, USA

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The editors are privileged to dedicate this edition of Geriatric Anesthesiology to the late Jeffrey H. Silverstein, MD, who at the time of his death (2015) was planning the third edition of the textbook that he personally, tirelessly saw reach its status as the authoritative volume of the knowledge of the anesthetic practice for geriatric patients. The second edition encapsulated his abiding interest in the science and education of anesthesia for the geriatric population. It was his desire that the next edition expand on this important aspect of anesthesiology.

As we reflect on the field of geriatric anesthesiology that has been blessed with many dedicated and visionary leaders, none have been as meaningful as Jeff Silverstein. His untimely death from cancer on July 27, 2015, was a huge loss to the specialty and all of us who knew and worked with him. Jeff was one of the original members of the American Society of Anesthesiologists (ASA) Committee on Geriatric Anesthesia when it was formed in 1992. Since then, he was involved in every significant aspect of the development of geriatric anesthesia. As an example of Jeff's leadership in the early 1990s, the American Geriatrics Society (AGS) began their programs to promote geriatric expertise in nonmedical specialties, including anesthesiology. The AGS began with advisory meetings that included representatives from geriatrics and ten nonmedical specialties. These formal and informal AGS Committees provided advice on outreach programs to be supported by the AGS. Over a 20-year span, Jeff was the most consistent representative from anesthesiology. His participation culminated during his tenure as chair of the AGS Section for Enhancing Geriatric Understanding and Expertise Among Surgical and Medical Specialists (SEGUE), and he was instrumental in the development of the JR and its successor, the NIH-funded Grants for Early Medical/Surgical Specialists' Transition to Aging Research (GEMSSTAR) award.

Jeff was a leading force in the formation of the Society for the Advancement of Geriatric Anesthesia (SAGA) (www.sagahq.org) in 2000 and was its second president. He was an active participant in the educational activities provided by SAGA members to the ASA, the AGS, the New York State Society of Anesthesiologists PostGraduate Assembly, and the Society of Cardiovascular Anesthesiologists. Jeff was active in geriatric research as well, with over 20 PubMed citations in geriatric anesthesiology alone. Most of this research was on the topic of postoperative cognitive decline.

Yet as meaningful as the above accomplishments are, they do not do justice to the person that Jeff was to many of us in geriatric anesthesiology. He was a colleague, a mentor, a leader, and a friend. Jeff had that special ability to cut through all the extraneous, distracting information and succinctly define the important issues and how to go about achieving them. His vision and implementation of the vision will perhaps be what is most sorely missed. We miss his insight and his effective, provocative manner that not only entertained us but challenged us to go beyond what we thought possible. Jeff's presence and deep, booming voice commanded attention, but it was his creative mind that really kept us moving forward.

We hope that this book is a fitting tribute to Jeffrey H. Silverstein, MD, who insisted on a thorough approach to the science and practical information required in providing optimal anesthesia care to the elderly.

Preface to the First Edition

Approximately 14% of the current US population is 65 years of age or older. By the year 2020, it is predicted that 20% or 60,000,000 Americans will reach this milestone. Further, if today's statistics continue unchanged, at least half of these individuals will undergo anesthesia and surgery, likely of increasing complexity, prior to their eventual demise. The geriatric patient population represents a huge and growing challenge for anesthesia providers the world over.

My interest in the anesthetic management of geriatric patients was kindled 15 years ago while on the faculty at Bowman Gray. One of our surgeons asked me to anesthetize his healthy 72-year-old father. All went well in the intraoperative and postoperative periods, and he was discharged home in the customary time frame. However, my colleague later reported that he had observed subtle psychomotor changes in his father which persisted postoperatively for 7 weeks. It dawned on me that perhaps the geriatric patient is not simply an older adult, but, rather, a truly different physiologic entity. What could explain the relatively commonly observed delayed postoperative return of normal mentation in the geriatric surgical patient? It is this and other unanswered questions regarding the anesthetic management of the elderly that stimulated the development of this text.

Geriatric Anesthesiology is designed to be a comprehensive text that methodically addresses the aging process while emphasizing important clinical anesthetic considerations. The first two sections of the text define the demographics of our aging population and describe age-related physiologic changes that occur in each major organ system. The third section addresses the multitude of factors that contribute to a safe and successful anesthetic with suggested adjustments in technique that may improve anesthetic management of the elderly. Topics range from preoperative evaluation and risk assessment to the altered effects of various classes of drugs with further discussion regarding positioning, thermoregulation, perioperative monitoring, and postoperative recovery. In addition, issues such as management of pain syndromes, outpatient anesthesia, medicolegal implications, and even special CPR techniques in this age group are considered. The fourth section identifies the ten most commonly performed surgical procedures in the elderly and, for each, offers recommended anesthetic techniques. The text ends with an intriguing exploration into future research opportunities in the field, including molecular mechanisms of aging.

Considerable energy has gone into the creation of this text. I am grateful for the significant efforts made by all the contributing authors and especially appreciate contributions made by the editors from Williams & Wilkins. The text would have been impossible to complete without the encouragement, dogged determination, and professionalism of Ms. Tanya Lazar and Mr. Carroll Cann. Tim Grayson was innovative and supportive during the original design and formulation of this project.

I am optimistic that this text will heighten the awareness of the very real clinical differences presented by the geriatric patient population. Perhaps by referring to appropriate sections in this text, anesthesia providers will be armed with a better understanding of the physiologic changes of aging and the recommended considerations and modifications of anesthetic technique, which we hope will contribute to an ever-improving outcome for the geriatric surgical patient population.

Charles H. McLeskey

Preface to the Second Edition

Do not go gentle into that good night, Old age should burn and rave at close of day; Rage, rage against the dying of the light.

Dylan Thomas

The goal of getting older is to age successfully. Unfortunately, the majority of our older patients will have acquired one or more chronic medical conditions as they age, and, even if a perfectly healthy older patient presents for surgery, that patient's ability to handle physiologic stress will be diminished, including the stress of surgery. Nearly half of all surgical procedures involve patients older than age 65, and that percentage is likely to increase as the US population ages. Thus, the perioperative care of the older patient represents one of the primary future frontiers of anesthetic practice. Even though perioperative mortality has diminished for the elderly, as well as for the population in general, the growing number of cases spotlights perioperative morbidity and mortality as an important issue for patients and healthcare systems alike. The vision set forward by the first edition (i.e., to apply the growing body of knowledge in this subspecialty area to the everyday practice of anesthesiology) remains the mission and vision of this second edition. The editors believe that the updated contents of this edition represent an important opportunity to consolidate and organize the information that has been acquired since 1997 and to apply that knowledge to the current practice of anesthesiology.

Part I contains several new chapters on topics that may not always seem to be directly involved with anesthetic care, but are important to the future of medical and anesthesia care. An understanding of the aging process may lead to methods of slowing its progression or at least of ameliorating some of its consequences, including the development of chronic disease. Most anesthesiology residency programs provide limited formal teaching of geriatric anesthesia. The editors believe the incorporation of relevant subspecialty material in the anesthesiology curriculum is needed to improve care for this patient population. The realities of reimbursement for services rendered to the older patient, either by Medicare or other payers, warrant the attention of all anesthesiologists who provide care for older patients. Ethics as applied to treatment of the older patient is also addressed. The medical management of this population is often complicated by issues such as patient goals that differ from physician expectations, physician "ageism," patient cognitive impairment, and the physician's failure to recognize the true risk of surgery and attendant recovery time. The last chapter of Part I reviews current knowledge and suggests research areas where the greatest impact on patient outcomes might be realized.

Parts II and III review the physiology of aging and the basic anesthetic management of the geriatric patient, and Part IV examines selected surgical procedures frequently performed in older patients. Not all of these chapters are specific to anesthetic management. Geriatric medicine is a broad field with many relevant topics. Wound healing is a perfect example. The reality is that anesthesiologists can likely have a positive impact on patient care by being better able to recognize conditions that may compromise skin when other medical professionals may fail to and, as a result, can improve protection of the skin, especially during long operating room cases. In contrast, polypharmacy and drug interactions, major topics in geriatric medicine, have direct relevance to anesthetic management. The cardiac surgery chapter is an example of

how age affects outcomes after a specific type of surgical procedure. The unusual aspects of anesthetic management for cardiac surgery revolve mostly around the patient's underlying disease status rather than there being anything specific to cardiac anesthesia in the older patient beyond the principles delineated in Parts II and III.

For chapters similar to those in the first edition, an effort has been made to update content and incorporate studies that examine outcome. Such work helps us challenge conventional wisdom and sometimes test novel ideas that prove beneficial. Even the most casual reader of this textbook will recognize huge gaps in our present knowledge. It is not sufficient, for example, to take an understanding of the physiology of aging and draw conclusions regarding anesthetic management from that information. Oftentimes, however, we are forced to do just that when making anesthetic management decisions. The editors hope the future will provide better research and answers that advance the field of geriatric anesthesiology.

The editors thank the many authors of this text. In addition to their hard work, they responded to entreaties for revisions and updates with admirable patience and promptness. Their contributions expand our knowledge and will improve the care of elderly patients.

Lastly, the editors thank Stacy Hague and Elizabeth Corra from Springer. Without their vision and determination, this book would not exist.

Jeffrey H. Silverstein
G. Alec Rooke
J.G. Reves
Charles H. McLeskey

Preface to the Third Edition

People all over the world are living longer. In fact, by percentage change, the over-65-year-old group is the fastest growing age group worldwide. According to the U.S. Census Bureau, by year 2030, nearly 20% of the population will be 65 years of age and older. Considering the burgeoning population and the fact that patients aged 65 and older are receiving procedures in disproportionate numbers to younger patients, it is imperative that anesthesiologists be prepared to care for an ever-increasing number of elderly patients. Thus, evidence-based perioperative care of the geriatric patient will only continue to grow in importance for the practicing anesthesiologist.

The mission of this edition remains the same as the previous two editions: to assemble the growing body of knowledge in geriatric anesthesia and provide it to the anesthesiologists for use in the everyday practice of anesthesia. However, as our knowledge regarding perioperative care of the elderly surgical patient grows, so do our questions. In this edition, we have asked all authors to include a section within each chapter entitled "Gaps in Our Knowledge." These sections highlight areas in which research is needed, as well as hopefully inspire readers to begin solving some of these questions.

This edition continues to build on the strong foundation of the first two editions. However, as the field of geriatric anesthesiology rapidly evolves, so does our focus on important new developments. Part I contains several new chapters that reflect the evolution of multidisciplinary geriatric care throughout the perioperative continuum. We highlight the evolving development of the Perioperative Surgical Home, as well as expound on the growing body of literature related to prehabilitation. In addition, in the theme of multidisciplinary collaboration, we have also included chapters on the surgeon's perspective and geriatrician's perspective on surgery in the geriatric population. This is important as medical care must continue to be a more collaborative effort as patients get older and sicker.

Parts II and III review the systematic physiologic changes associated with aging and the pharmacologic considerations for the geriatric patient undergoing procedures. These chapters are necessary components to any comprehensive textbook on geriatric anesthesia, and while much of the material is similar to that of the last two editions, an effort has been made to update any information relevant to the changing practice of geriatric anesthesia. For example, in the chapter on chronic medication use in the elderly, particular focus was placed on certain rapidly developing medications that impact practice such as antidepressants and new anticoagulants.

Part IV, special concerns, has also undergone major changes. There are more minimally invasive procedures being performed outside the operating rooms or in hybrid operating suites which pose specific challenges for geriatric patients. We have highlighted these changes in practice within this section, including expanding chapters on cardiovascular procedures related to minimally invasive valvular procedures as well as monitored anesthesia care and NORA procedures. In addition, we included a chapter solely dedicated to implantable pacemakers and ICDs as both perioperative management of these devices and anesthetic management for heart and vascular procedures are growing in volume. The anesthetic management of patients undergoing surgery for cancer entails special considerations, and since the elderly commonly undergo such procedures, a chapter on this topic has been added. The elderly are also subject to trauma, and there is a growing knowledge base on trauma care for the older patient. This

section also includes chapters on management of elderly patients undergoing cardiothoracic/vascular surgery and orthopedic surgery. There is an especially large body of knowledge on orthopedic surgery in the elderly, much of which has arisen from outside the USA.

Finally, in this edition, we have added a Part V that focuses on postoperative care specific to the geriatric population which includes acute pain management, ICU management, recent evidence and up-to-date practice regarding delirium and postoperative cognitive dysfunction, and palliative care. As the role of the anesthesiologist continues to expand outside of the operating room, it is imperative that we continue to practice evidence-based care for the geriatric patient within these settings.

Charleston, SC, USA — J.G. Reves
Boston, MA, USA — Sheila Ryan Barnett
Charleston, SC, USA — Julie R. McSwain
Seattle, WA, USA — G. Alec Rooke

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The editors thank all the authors of this text for their thoroughness in content as well as their prompt responses for revisions and updates. Their contributions will undoubtedly improve the care of geriatric patients. We especially thank our developmental editor Michael D. Sova and Springer Publishing for their encouragement, diligence, and determination to get this book to print.

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Contributors

James H. Abernathy III, MD, MPH Department of Anesthesiology and Critical Care Medicine, Division of Cardiac Anesthesia, Johns Hopkins Medicine, Baltimore, MD, USA

Shamsuddin Akhtar, MBBS Department of Anesthesiology and Pharmacology, Yale University School of Medicine, New Haven, CT, USA

Daniel A. Anaya, MD Department of Gastrointestinal Oncology, H. Lee Moffitt Cancer Center & Research Institute, Tampa, FL, USA

Michael Anderson, MD Department of Anesthesiology, Icahn School of Medicine at Mount Sinai Hospital, New York, NY, USA

Sheila Ryan Barnett, MD Department of Anesthesiology, Critical Care and Pain Medicine, Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, MA, USA

Katherine A. Bennett, MD Department of Medicine, Division of Gerontology and Geriatric Medicine, University of Washington, Seattle, WA, USA

Itay Bentov, MD, PhD Department of Anesthesiology and Pain Medicine, Harborview Medical Center/ University of Washington, Seattle, WA, USA

Jack M. Berger, MS, MD, PhD Department of Anesthesiology, Keck School of Medicine of USC, Los Angeles, CA, USA

Miles Berger, MD, PhD Department of Anesthesiology and Center for Cognitive Neuroscience, Duke University Medical Center, Durham, NC, USA

Guillaume Bousquet-Dion, MD Department of Anesthesia, McGill University Health Center, Montreal, QC, Canada

Roberto Cabeza, PhD Center for Cognitive Neuroscience, Duke University, Durham, NC, USA

Francesco Carli, MD, MPhil Department of Anesthesia, McGill University Health Center, Montreal, QC, Canada

Rodrigo Cartin-Ceba, MD Department of Anesthesiology, Mayo Clinic College of Medicine, Scottsdale, AZ, USA

Lynn Cintron, MD, MS Department of Anesthesia and Perioperative Care, University of California, Irvine, Orange, CA, USA

Carol A. Crawford, BSc, PharmD Department of Pharmacy, University of Washington – Harborview Medical Center, Seattle, WA, USA

Stacie G. Deiner, MD Departments of Anesthesiology, Neurosurgery, Geriatrics, and Palliative Care, Icahn School of Medicine at Mount Sinai, New York, NY, USA

Anahat Dhillon, MD Department of Anesthesiology, University of California Los Angeles, Los Angeles, CA, USA

Anushree Doshi, MD, BA Department of Anesthesiology, Duke University Medical Center, NC, USA

George A. Dumas, MD Department of Anesthesiology and Perioperative Medicine, University of Alabama at Birmingham, Birmingham, AL, USA

Thomas J. Ebert, MD, PhD Department of Anesthesiology, Medical College of Wisconsin and Zablocki VA Medical Center, Milwaukee, WI, USA

Catalin Ezaru, MD Department of Anesthesiology, University of Pittsburgh and VA Hospital Pittsburgh, Pittsburgh, PA, USA

Neal S. Fedarko, PhD Department of Medicine, Johns Hopkins University, Baltimore, MD, USA

Ana Fernandez-Bustamante, MD Department of Anesthesiology, University of Colorado School Of Medicine, Aurora, CO, USA

Pamela Flood, MD Department of Anesthesiology, Perioperative and Pain Medicine, Stanford University, Palo Alto, CA, USA

Vijaya Gottumukkala, MBBS, MD (Anes), FRCA Department of Anesthesiology and Perioperative Medicine, The University of Texas MD Anderson Cancer Center, Houston, TX, USA

George Jospeh Guldan III, MD Department of Anesthesiology and Perioperative Medicine, Medical University of South Carolina, Charleston, SC, USA

Allen N. Gustin Jr., MD, FCCP Stritch School of Medicine, Loyola University Medical Center, Chicago, IL, USA

Gary R. Haynes, MS, PhD, MD Department of Anesthesiology, Tulane University School of Medicine, New Orleans, LA, USA

Timothy L. Heinke, MD Department of Anesthesiology and Perioperative Medicine, Medical University of South Carolina, Charleston, SC, USA

Paul J. Hoehner, MD, MA, PhD (cand) Department of Anesthesiology and Critical Care Medicine, The Johns Hopkins Medical Institutions, Baltimore, MD, USA

Melissa A. Hornor, MD Continuous Quality Improvement, American College of Surgeons, Chicago, IL, USA

Joe C. Huang, MD Department of Medicine, Division of Gerontology and Geriatric Medicine, University of Washington, Seattle, WA, USA

Michelle Humeidan, MD, PhD Department of Anesthesiology, The Ohio State University Wexner Medical Center, Columbus, OH, USA

Nicholas Koenig, BS The Ohio State University College of Medicine, Columbus, OH, USA

Jacqueline M. Leung, MD, MPH Department of Anesthesia and Perioperative Care, University of California, San Francisco, San Francisco, CA, USA

Michael C. Lewis, BSc (Hons), MBBS Department of Anesthesiology, Pain Management, and Perioperative Medicine, Henry Ford Health System, Detroit, MI, USA

Cynthia A. Lien, MD Department of Anesthesiology, Weill Cornell Medical College, New York, NY, USA

Linda Liu, MD Department of Anesthesia and Perioperative Care, University of California, San Francisco, San Francisco, CA, USA

Gary E. Loyd, MD, MMM Department of Anesthesiology, Henry Ford Health System, Detroit, MI, USA

James D. McDonald, MD Department of General Surgery, University of South Florida, Morsani College of Medicine, Tampa, FL, USA

Matthew D. McEvoy, MD Department of Anesthesiology, Vanderbilt Univerisity Medical Center, Nashville, TN, USA

Tracy Jobin McGrane, MD Department of Anesthesiology, Vanderbilt University Medical Center, Nashville, TN, USA

Rodney K. McKeever, MD Department of Anesthesiology, LAC+USC Medical Center/ USC Keck School, Los Angeles, CA, USA

Julie R. McSwain, MD, MPH Department of Anesthesia and Perioperative Medicine, Medical University of South Carolina, Charleston, SC, USA

Thuan Ong, MD, MPH Department of Medicine, Division of Gerontology and Geriatric Medicine, University of Washington, Seattle, WA, USA

Ronald Pauldine, MD Department of Anesthesiology and Pain Medicine, University of Washington, Seattle, WA, USA

May J. Reed, MD Department of Medicine, Harborview Medical Center/University of Washington School of Medicine, Seattle, WA, USA

J.G. Reves, MD Department of Anesthesia and Perioperative Medicine, Medical University of South Carolina, Charleston, SC, USA

G. Alec Rooke, MD, PhD Department of Anesthesiology and Pain Medicine, University of Washington, Seattle, WA, USA

Ronnie Ann Rosenthal, MS, MD Department of Surgery, Yale University School of Medicine – VA Connect Health Care System, West Haven, CT, USA

Daniel I. Sessler, MD Department of Outcomes Research, Cleveland Clinic, Cleveland, OH, USA

Steven L. Shafer, MD Department of Anesthesiology, Perioperative and Pain Medicine, Stanford University, Palo Alto, CA, USA

Sonalee Shah, DO Department of Anesthesiology, Pain Management and Perioperative Medicine, Henry Ford Health System, Detroit, MI, USA

B. Bryce Speer, DO Department of Anesthesiology and Perioperative Medicine, The University of Texas MD Anderson Cancer Center, Houston, TX, USA

Juraj Sprung, MD, PhD Department of Anesthesiology, Mayo Clinic College of Medicine, Rochester, MN, USA

Tamas A. Szabo, MD, PhD Department of Anesthesiology, Ralph H. Johnson VA Medical Center, Charleston, SC, USA

Laura Tarlow, MBA, CMPE Private Physician Practice, Anesthesia Consultants of New Jersey, LLC, Somerset, NJ, USA

David O. Warner, MD Department of Anesthesiology, Mayo Clinic College of Medicine, Rochester, MN, USA

R. David Warters, MD Department of Anesthesiology, Ralph H. Johnson VA Medical Center, Charleston, SC, USA

Toby N. Weingarten, MD Department of Anesthesiology, Mayo Clinic College of Medicine, Rochester, MN, USA

Stephanie Whitener, MD Department of Anesthesiology, Medical University of South Carolina, Charleston, SC, USA

John P. Williams, MD Department of Anesthesiology, University of Pittsburgh, Pittsburgh, PA, USA

Sylvia H. Wilson, MD Department of Anesthesia and Perioperative Medicine, Medical University of South Carolina, Charleston, SC, USA

Part I

Fundamentals

Geriatric Anesthesiology: Where Have We Been and Where Are We Going?

1

Julie R. McSwain, J.G. Reves, Sheila Ryan Barnett, and G. Alec Rooke

Introduction

The subject of anesthesiology spans the science and art of an entire clinical discipline. This includes material of basic and clinical sciences as well as particular pharmacology that encompass drugs to render man insensitive to pain, induce loss of consciousness, and paralyze muscles [1]. Geriatric anesthesiology is an emerging, important area more narrowly focused on the art, science, pharmacology, and physiology pertaining to the elderly surgical population. Age is an imperfect descriptor of geriatric anesthesia because age alone does not define the important changes that make older patients more challenging and different than normal adults. Nevertheless, age ≥65 years old is used arbitrarily to define the geriatric population.

Geriatric medical care has evolved from an empiric discipline in the 1950s and 1960s to a largely evidence-based practice today [2]. An excellent short reference guide called *Geriatrics at Your Fingertips* is available in a small pocket edition as well as on the Internet [3]. Perioperative geriatric anesthesia is very much at the frontlines of developing sufficient primary data on which to base practice guidelines. However, there are still only a few randomized controlled trials that provide class I evidence regarding perioperative care of the elderly, leaving the practitioner to extrapolate findings from literature that has accumulated on geriatric care in other contexts that pertain to the perioperative setting.

J.R. McSwain • J.G. Reves (✉)
Department of Anesthesia and Perioperative Medicine, Medical University of South Carolina, Charleston, SC, USA
e-mail: revesj@musc.edu

S.R. Barnett
Department of Anesthesiology, Critical Care and Pain Medicine, Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, MA, USA

G. Alec Rooke
Department of Anesthesiology and Pain Medicine, University of Washington, Seattle, WA, USA

This introductory chapter presents some of the foundational concepts of geriatrics and a general approach to caring for geriatric patients presenting for surgery. In approaching elderly patients, the anesthesiologist must recognize that there is tremendous heterogeneity or variability in aging, both in the body as a whole and in individual organ systems. Thus, the alterations described in this book are likely, on average, to be presented in geriatric surgical patients, but each individual patient will manifest these changes differently. The reader is encouraged to develop expertise and judgment to identify those areas in need of improved approaches with the goal of developing an evidence-based practice for perioperative geriatric care. To facilitate this, each chapter identifies gaps in our knowledge that are meant to stimulate investigation to extend our knowledge of geriatric anesthesiology through future research.

History of Geriatric Anesthesia

Interest in geriatric anesthesia can be found as far back as the mid-1940s in the form of a journal article [4] and in the 1950s with a textbook [5], but very little can be found thereafter until the mid-1980s when five textbooks appeared [6–10]. Medical meetings such as the American Society of Anesthesiologists (ASA) annual meeting did not have much specific geriatric content until the mid-1980s, but the Geriatric Anesthesia Symposium held at Washington University was an exception. Believing that geriatric anesthesia was not receiving the attention it deserved, Dr. C. Ronald Stephen, department chair, assigned Dr. William Owens to organize the multiday meeting held annually in St. Louis, MO, from 1974 to 1994 [11].

Awareness of the importance of geriatric anesthesia began to gain momentum in earnest in the early 1990s when the ASA formed the Committee on Geriatric Anesthesia in 1991. The first meeting was held in July 1992. The creation of a formal geriatric section of the ASA proved fortuitous because not long thereafter the American Geriatrics Society (AGS)

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began reaching out to ten surgical-related specialties. The AGS needed each specialty to participate in strategic planning meetings, and anesthesiologists were drawn from the ASA Committee on Geriatric Anesthesia. Simultaneously, the American Federation for Aging Research sponsored two separate 2-year fellowships in geriatric anesthesia that ran from 1992 to 1994, but this was a one-time program.

The ASA Committee on Geriatric Anesthesia has always focused on providing educational opportunities. From 1998 onward, the Committee has organized at least one panel for the ASA meeting every year but one. The Committee has also developed multiple educational products over the years. The first was the Syllabus on Geriatric Anesthesia, published online in 2002 [12]. Later, the Geriatric Anesthesiology Curriculum [13] and a Frequently Asked Questions document were published by the ASA [14]. All of these documents were developed to assist the busy practitioner as well as anesthesia residents and other health-care providers.

In an effort to improve visibility of geriatrics and establish the importance of geriatrics within anesthesiology, the Committee developed and submitted a white paper to the ASA Board of Directors in January of 2013. The major recommendation was to create a geriatric anesthesia educational track for the annual ASA meeting. With acceptance of this recommendation, the Educational Track Subcommittee on Geriatric Anesthesia was created, and the Abstract Subcommittee was moved out of ambulatory anesthesia into its own entity. The track successfully "went live" at the 2016 ASA annual meeting and included an approximately a doubling of the educational material presented on geriatric anesthesia at the meeting. This was a major accomplishment for the Geriatric Committee and the field of geriatric anesthesiology in general.

The Geriatric Committee has served as a liaison to other medical societies and provided many expert reviews both formally and informally. For example, when the American Academy of Orthopaedic Surgeons wanted anesthesiologist input into their management guidelines for hip fractures in elderly patients, the Committee was contacted and provided feedback [15]. Committee members have presented talks and panels on geriatric anesthesia to other societies, including general surgery, thoracic surgery, and geriatric medicine, as well as to multiple anesthesia subspecialty societies.

By the late 1990s, it became apparent that there were many more ASA members interested in geriatric anesthesia than could be accommodated by the Committee. The desire to provide opportunity for involvement by more ASA members and permit greater exchange of ideas led to the formation of the Society for the Advancement of Geriatric Anesthesia (SAGA) in 2000. From the start, the activities of SAGA and the ASA Committee on Geriatric Anesthesia have been intertwined. SAGA members have supported Committee projects, in large part because their leadership has been integral members of both groups. In addition, most of the non-Committee members who have contributed to the Committee's published documents and educational programs have been SAGA members [11]. SAGA maintains an active website [16] (www.sagahq.org) with links to many educational materials, meetings, and grants. SAGA also has an annual meeting that has been held during the ASA national meeting, during which society business is conducted and a scientific presentation is provided. Since 2007 SAGA has made financial contributions annually to the Foundation for Anesthesia Education and Research to support projects with a geriatric basis. SAGA has cosponsored meetings in partnership with the anesthesiology departments at the Hospital for Special Surgery in New York City and the MD Anderson Cancer Center in Houston. SAGA remains small but has a significant impact on geriatric anesthesia because its members are extremely active in ASA leadership; in the anesthesia community at large, educational publications; and in research. The most prominent research topics in geriatric anesthesia have been postoperative delirium and postoperative cognitive dysfunction.

The closest outside relationship for both the ASA Committee on Geriatric Anesthesia and SAGA has been with the American Geriatrics Society [17]. The AGS has taken the position that there will be too few geriatricians to care for our aging population. Consequently, geriatric expertise needs to be present in all medical specialties and that training in geriatrics needs to be a part of residency programs. This concept extends to non-internal medicine specialties as well [18]. The Geriatrics for Specialists Project began in 1994 in partnership with five such specialties and expanded to ten specialties (including anesthesiology) in 1997. With support from the John A. Hartford Foundation, educational grants to these ten specialties began in 1998. The process became more established beginning in 2001, and since then, anesthesia programs have received nine grants to develop educational programs to enhance resident training in geriatrics.

Through 2000, AGS sponsored meetings of AGS geriatricians and representatives from each of the ten non-internal medicine specialties were organized on an ad hoc basis and were primarily planning and strategy meetings. This structure changed with the creation of a section of the AGS, the Section for Enhancing Geriatric Understanding and Expertise among Surgical and Medical Specialists known as SEGUE. The leadership Council for SEGUE comprised leaders as described above, but SEGUE itself now provides an educational program at the annual AGS meeting. The specialty societies became responsible for supporting the meetings of the SEGUE Council, and anesthesiology has been well represented. Dr. Jeffrey Silverstein, one of the founders of SAGA, was also the Council Chair from 2007 to 2009.

The SEGUE Council has also encouraged research in geriatric care in the nonmedical specialties. Toward this goal, the AGS first published a monograph in which each specialty contributed a state of the art knowledge summary and opinions as to where future research needed to be directed [19]. The Council also recognized greater interest in geriatrics could be generated if a core group of researchers and leaders in each field were created. This goal led to the creation of the Jahnigan award that provided not only generous research support but support for education on geriatric medicine and specialty-specific patient care. Beginning in 2002, approximately ten new awards have been given annually among the non-internal medicine specialties [20]. Funding from the Hartford Foundation was for a limited time period, so in 2011 the National Institute of Aging initiated the GEMSSTAR [21] award to cover the research activities of the awardee. Financial support of the educational aspect of the award (what the Jahnigan award now represents) comes from the individual specialties, with the Foundation for Anesthesia, Education and Research often providing partial support for awardees from anesthesiology. From 2002 to 2015, anesthesiology has received a total of 11 awards. Besides supporting research, from 2001 to 2009, the AGS funded projects by academic departments, with the goal of producing educational materials that could be shared with all training programs [22]. Nine grants were awarded in anesthesiology. The resulting teaching materials can be found in the Geriatrics for Specialists section of the American Geriatrics Society website [23].

The future of geriatric anesthesia looks bright. The ASA, as well as the European Anaesthesiology Conference, has formal sections in their meetings that are devoted to geriatrics. SAGA [16] and the Age Anaesthesia Association in the UK [24] represent societies dedicated to geriatric anesthesia. Several recent textbooks address the field [2, 25, 26], and considerable research is ongoing on topics that primarily affect older patients, such as postoperative delirium and cognitive dysfunction. The role of the anesthesiologist with geriatric expertise, however, remains to be fully defined. Certainly such individuals need to serve as resources for others in the specialty, but do elderly patients need to be managed by specially trained anesthesiologists? At present, the answer is "no," but it is also clear that most anesthesiologists could be better informed about the management of the elderly, especially the frail elderly. This text is an attempt to provide much of that knowledge.

Demography

The population of the world overall is increasing, and the USA is expected to see its population grow from 314 million in 2012 to 400 million in 2050, a 27% increase [27]. With this population increase, there is a particularly large increase in people 65 and over [27, 28] (Fig. 1.1). Less than 5% of the US population was over 65 years old in 1900, and 13% were over 65 years old in 2000. However, by 2030, according to the US Bureau of the Census, approximately 20% of the population may be greater than 65 years of age [28]. In 2050, the over 65-year-old population in the USA is projected to be 83.7 million, almost double the 2012 estimate of 43.1 million. The average life expectancy for men and women in the USA is expected to increase from 82.5 in 2017 to 86.6 in 2050. The life expectancy varies by race and gender, but cumulative life expectancy is increased in each group when reaching the age of 65 and 85. This means that if one attains each of these advanced ages, expectancy increases in the older cohort [29]. Women life's expectancy is greater than men, but this difference becomes less significant as the cohorts increase in age. People over 65 years of age are the fastest-growing age group in the USA [30]. Of note, the fastest-growing segment of the population is that aged 90 years and older, and this will further challenge our physicians and clinical facilities.

Reasons for the marked increase in elderly patients relative to the overall population are many. A simplified explanation is that both mortality and fertility rates are decreasing. This inevitably increases the percentage of elderly. Fundamental contributions to longevity are genetic makeup as well as socioeconomic and geographic factors. Genes determine what diseases develop, as well as whether drugs are effective treatments for disease in specific people. Racial and socioeconomic factors often contribute to longer life with advantages found in white and economically advantaged populations. Another reason for the growth in the over 65 years of age cohort is the baby boom generation. The baby boom generation is defined as people born from 1946 to 1964. As the baby boom generation progresses in age, the percentage of over 65 should stabilize in 2030 (see Fig. 1.1). Other contributing factors to healthy aging include medical advances reflected by the remarkable decrease of early deaths from ischemic heart disease and many cancers. Improved knowledge, diagnosis, medicines, and procedures have led to major improvements in the survival of patients with these chronic diseases. Public health has also played a major role in extending life expectancy. There are better water sources, food, immunizations, sanitation, and approaches to communicable disease that have all led to greater survival. Finally, and importantly, lifestyle changes have conferred longevity, for example, cessation of smoking, regular exercise, improved diet, and drinking habits.

Within the USA, there is a nonuniform distribution of population over 65. In the USA, Fig. 1.2 [31] shows wide variation in each state in the percentage of population over 65. Some states have seen much greater growth in their older populations between 1999 and 2009 than others with Alaska

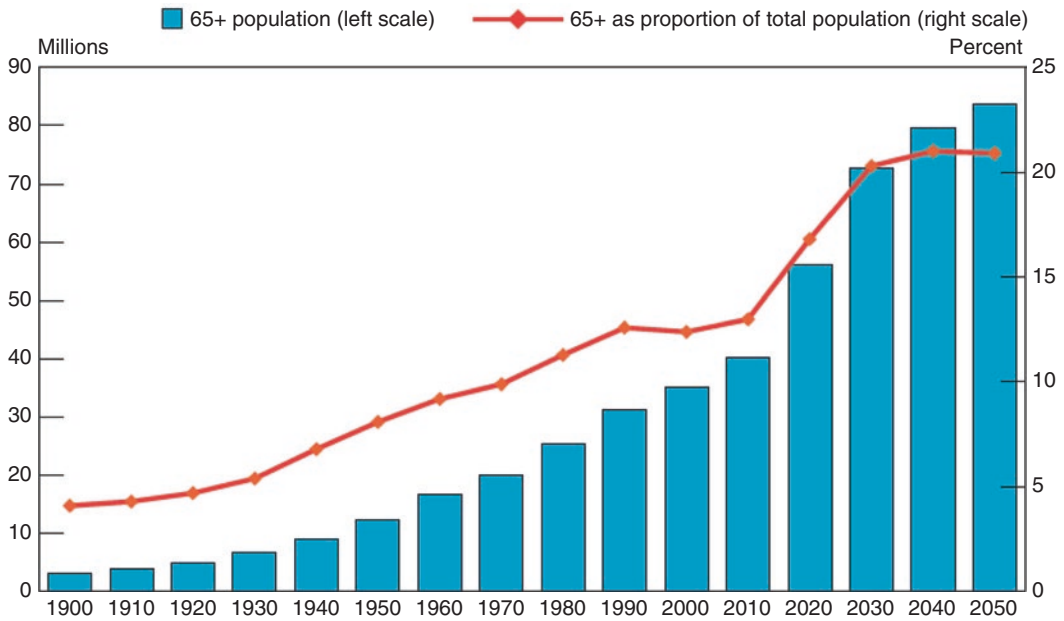

Fig. 1.1 Population aged 65 and over: 1900–2050. This figure depicts (*bars*) the 65 years old population of the USA from 1900 and projected to 2050. Note the marked increase until 2030 when the percentage (*line*) of geriatric people flattens at about 22%. (For information on confidentiality protection, nonsampling error, and definitions, see www.census.gov/prod/cen2010/doc/sf1.pdf) (Reprinted from U.S. Census Bureau, P. et al. [32])

(50.0%), Arizona (32.1%), Colorado (31.8%), Georgia (31.4%), Idaho (32.5), Nevada (47.0%), South Carolina (30.4), and Utah (31.0%) all experiencing 30% or more 10-year increase in their elderly population. However, in absolute numbers of elderly citizens in the 2010 census, over half (56.5%) of persons 65+ lived in 11 states: California (4.3 million), Florida (3.3 million), New York (2.6 million), Texas (2.6 million), Pennsylvania (2.0 million), and Ohio, Illinois, Michigan, North Carolina, New Jersey, and Georgia each having well over 1 million [31].

Like the various states in the USA, there is great variation in the world distribution of elderly people. Figure 1.3 [32] shows the forecasted change in global distribution of people over 65. Europe and North America have the largest percentage of over 65 among major world regions. The USA had 13.1% of population over 65 in 2010 and is relatively young compared to some countries like Germany, Italy, Japan, and Monaco with populations of 20% over 65 [32]. The developed countries of the world tend to have the older populations because of increased life expectancy and reduced fertility. However, by 2050 it is predicted that 100 countries will have a population with at least 20 percent of their population over 65. A shift in world population is predicted to occur between 2015 and 2020 when the percentage of people over 65 will for the first time be greater in the world than those under 5. The less developed countries are expected to make gains in their older populations, taxing their ability to provide the necessary medical and social care required by older people. The US Census Bureau has aptly summarized the impending growth in elderly populations of the USA and world: "Both individuals and society need to prepare for population aging; the cost of waiting- financial and social- could be overwhelming" [32]. It is clear that there is a need for the medical community to prepare for this major change in our demographic makeup.

Health Implications of an Aging Population

People older than 65 typically have one or more chronic diseases [32]. These diseases may require specific pharmacologic therapy or even surgery and may limit physical activity. The prevalence of chronic diseases that limit activity in geriatric patients is shown in Fig. 1.4. Note that all diseases increase with age, but problems with vision, hearing, and senility become more prevalent by age 85. Arthritis is a very common ailment that can progress even with appropriate therapy. About 50% of people over age 65 have arthritis with women affected more than men.

Geriatric patients can suffer from a number of chronic cardiovascular diseases. For example, coronary artery disease is very prominent and is more common in men. Ischemic heart disease can lead to increased risk of perioperative myocardial infarction which has a high morbidity and mortality. Valvular disease is also prevalent in the elderly and tends to affect the aortic and mitral valves. These valves may either be stenosed or incompetent. Altogether, 96 per 1000 people have cardiovascular disease that significantly impacts their

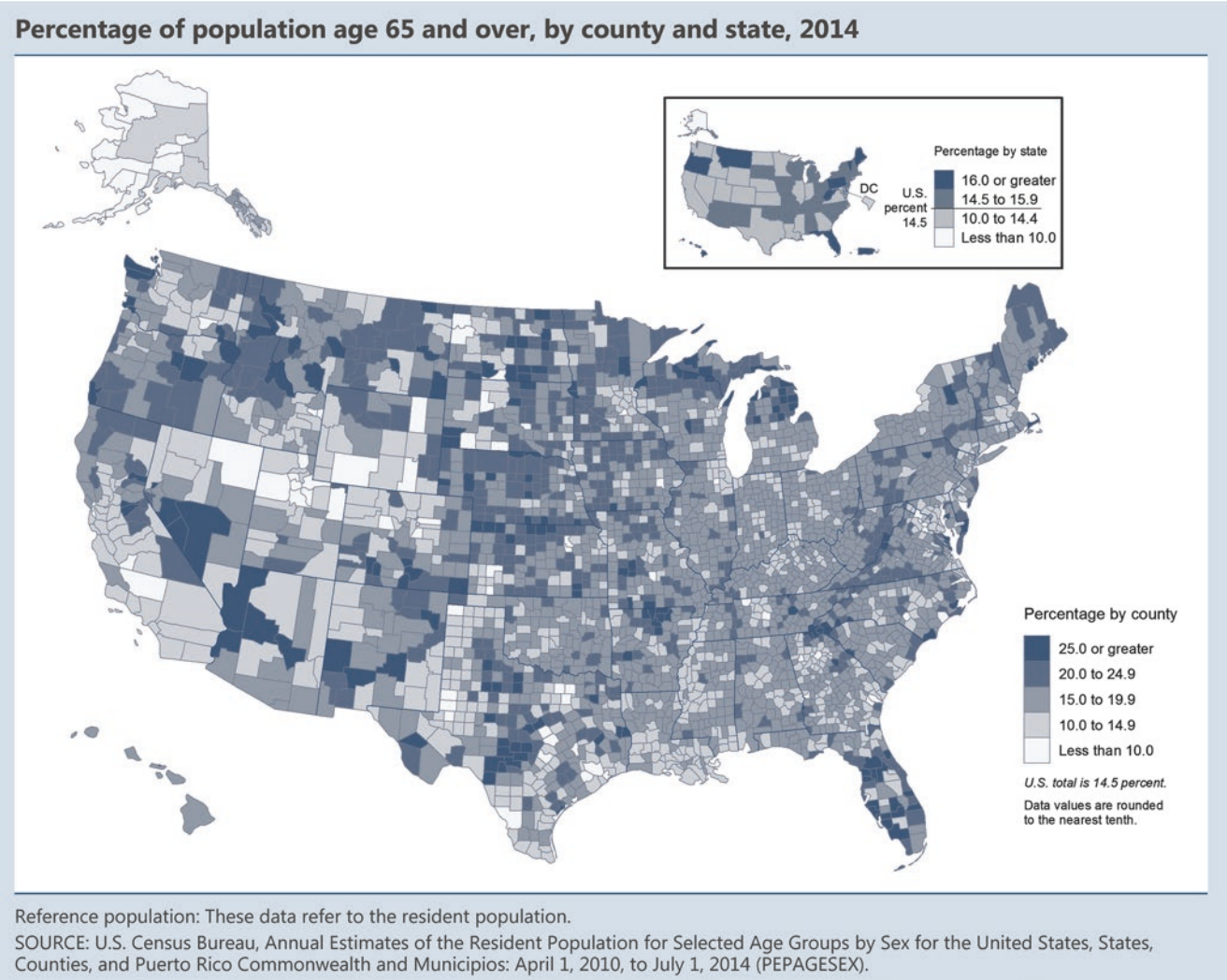

Fig. 1.2 Distribution by state of people over 65 as a percent of population. This figure shows that there is a wide variation in the over 65-year-old population with the greater concentration in the South, Southwest, Northeast, and lower Midwest. (The *darker* the color the higher the percentage of a state's geriatric population) (Reprinted from Federal Interagency Forum on Aging-Related Statistics [66])

activity [32]. This number increases to approximately 204 per 1000 over the age of 85 years, with women and men being equally affected. The process of atherosclerosis also affects other blood vessels in the body jeopardizing the integrity of the vessels themselves and the organs they supply. For example, stroke is the leading cause of severe long-term disability and affects older Americans more frequently. About 75% of strokes afflict people over 65 years old, and the risk doubles every 10 years after age 55 [33]. A prominent risk factor for stroke is hypertension. Hypertension affects about half of the population over 65, and it is slightly more prevalent in women. It should be treated aggressively to prevent heart disease and stroke as well as contribute to a stable hemodynamic perioperative course.

Common metabolic diseases that affect the geriatric population are diabetes and osteoporosis. Diabetes type 2 afflicts a large majority of older people, but surprisingly its diagnosis does not increase with age. Thus, diabetes is likely a chronic disease that develops before age 65 [32]. Careful management of diabetes is important as it is a precursor to a number of other serious diseases, including ischemic heart disease and stroke. Osteoporosis makes bones more brittle and prone to fracture, and women are more likely to develop this disease than men. The bones most affected by osteoporosis are the spine, hip, and wrist. Osteoporosis can also lead to fractures that require surgery. In fact, hip fractures are common and can lead to serious morbidity and mortality. Older people who have a hip fracture are three to four times more likely to die in 3 months than those who do not suffer a hip fracture [34, 35].

Half of the people diagnosed with cancer are 65 or older [32, 36]. This is a result of the increased longevity

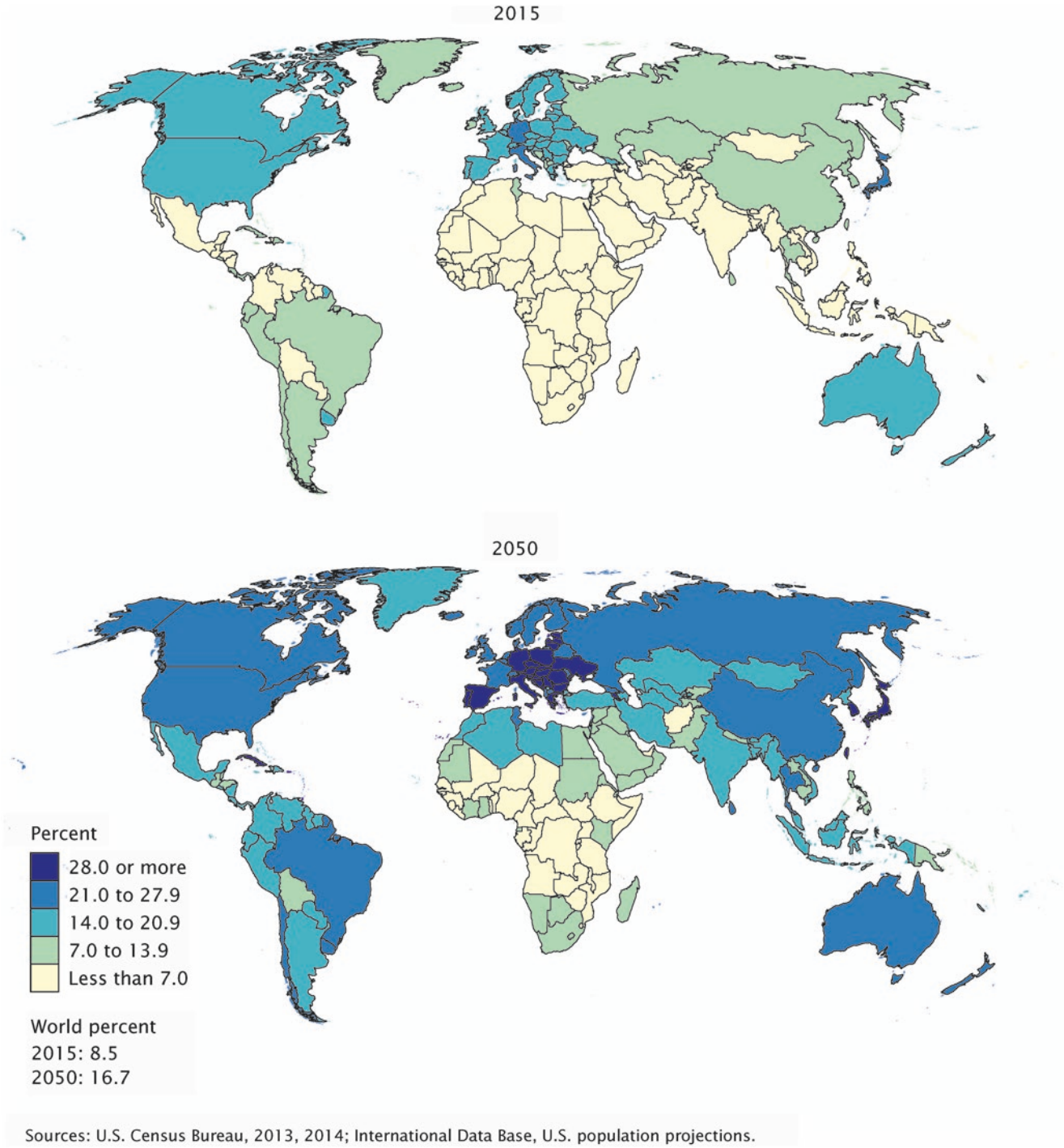

Fig. 1.3 Percentage of population aged 65 and over: 2015 and 2050. This figure demonstrates that aging is a global problem. The number of countries worldwide with populations over 65 greatly increases between 1015 and 2050 (Reprinted from He et al. [67])

of people as well as an increase in some cancers in the elderly. The major significance of cancer to the anesthesiologist is that many patients have operations designed to cure or palliate. Prostate and breast cancers now have 5-year survival of ≥90%. This is in stark contrast to lung cancer with the low survival rate of 16%. The results of surgical treatment of cancer are about the same as younger patients in many types of cancer with slightly higher complication rates seen in the geriatric population [36]. Thus, it is reasonable to expect that as the population ages, there will be more surgical oncologic procedures.