

Chapter

1

Epidemiology of Critical Illness in the Elderly

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Key Points

- Caring for the aging population is one of the most important challenges of the twenty-first century. A key component of medical care delivery in the elderly is the provision of critical care services.
- In addition to chronologic age, disability, comorbidity, and frailty are components of defining the elderly population. Frailty is a clinical syndrome characterized by multiple factors, including weight loss, fatigue, weakness, low activity level, slow motor performance, balance and gait abnormalities, and cognitive decline. A combination of age, function, and social definitions is key to precisely defining the elderly population.
- The demographics of the global and US populations have changed dramatically over the course of the last two centuries as a consequence of demographic transition, which defines a transition in a population from high birth and death rates to low birth and death rates as a result of economic development.
- The world population reached 7.3 billion in 2015 and has aged at unprecedented rates. By 2050, the number of elderly in the world will, for the first time in history, be greater than the number of young individuals.
- The sharp increase in the US birth rate between 1946 and 1964 is termed the *baby boom*. This has resulted in a drastic shift in the age distribution of the population. In 2015, the median age in the United States was 37 years, and it is estimated that this will increase to 42 years by 2050. Conversely, the total fertility rate in the United States has been declining and was 1.89 in 2015. Therefore, the growth rate of the elderly population is far higher than that of the younger population.
- Chronic medical conditions are expensive to treat. Multimorbidity is the presence of two or more chronic diseases and is common in the elderly, with a prevalence of 40 to 80 percent. It has a substantial impact on mental health, quality of life, and overall health outcomes and is associated with a significant increase in mortality. Disability in the elderly may have an even greater impact on mortality than multimorbidity.
- The elderly population comprises an increasing proportion of patients admitted to intensive care units (ICUs), and the mortality rate for these patients is high. Equally important is the significantly decreased physical function and overall health of ICU survivors.

- The United States spent nearly \$3 trillion in healthcare expenses in 2014, which is 17.5 percent of the gross domestic product (GDP), a percentage higher than that of any other country. The elderly use a large portion of the total healthcare expenditure in the United States due to the high hospitalization and institutionalization rate. Healthcare spending increases proportionally with age.
- Areas of opportunity for improvement in the allocation of healthcare resources to the elderly include enhanced awareness and education, studies that precisely define and stratify the elderly, and changing focus from survival to mitigation of cognitive impairment, improvement in quality of life, and an increase in functional autonomy. Identification of the best approach to provide multidisciplinary care ranging from surgical and critical care to palliative care in a manner that enhances communication and achieves desired outcomes will improve the quality of care and reduce healthcare expenditures.

Introduction

Caring for the aging population is one of the most important challenges of the twenty-first century. Media outlets, political figures, books, and television programming frequently elaborate on the difficulties the world will face as the age of the population increases [1]. Studies also indicate that not only are people living to an older age, but they may also have an increased number of quality years, as defined by better cognitive function and self-perceived health at the end of life [2]. Therefore, the aging population has become a topic that deserves attention from the medical community.

As the population age increases, so does the body of medical literature examining the best medical practices to care for the elderly. However, to understand the literature, we must first define the elderly population, evaluate the impact this population has on the medical system, and understand its significance in the current medical culture. A key component of medical care delivery in the elderly is the provision of critical care services.

Definition of the Elderly

In order to understand the unique complexities of the elderly patient, we must first define the elderly population. One way to define elderly age is based on lifespan. In nineteenth-century Britain, the Friendly Societies Act defined old age as “any age after 50.” At that time, the average life expectancy at birth was only 47.3 years. Therefore, population groups older than 50 years of age represented a minority of the population [3]. Today, most epidemiologists would argue that the definition of the elderly should be fluid and adjusted in accordance with the ever-increasing life expectancy. According to the Centers for Disease Control and Prevention (CDC), the expected lifespan for Americans at birth in 2013 was 78.8 years, which is a two-year increase from the year 2000 [4]. As healthcare continues to change and life expectancy continues to rise, it becomes necessary to use a metric other than chronologic age to define the elderly.

Medicare Definition

President Johnson passed the Medicare law under Title XVIII of the Social Security Act in 1965. Medicare aimed to provide health insurance to the elderly (people 65 years of age and older) regardless of their sociodemographic status [5]. Because of the significant impact this

act had on the medical world, and because of the large number of patients covered by Medicare, much of the medical literature defines elderly age using the chronologic age of 65 years or older. Medicare covered nearly 40 million elderly individuals in 2010 and financed an estimated 15.3 million hospital admissions in 2011, which accounted for almost 47 percent of the total inpatient hospital costs in the United States in 2011 [6].

Global Definition

According to the World Health Organization (WHO), 71 years was the average life expectancy of the global population in 2013. However, the average life expectancy in developing countries is as low as 50 years [7]. Most developed countries use the age of 65 years as the cutoff to define an older person, but in developing countries this definition does not necessarily correlate.

Aging is a chronologic biologic certainty, but it is also subject to the social constructs of cultures. In developed countries such as the United States, chronologic age plays a paramount role. However, in developing countries, the change in social roles plays a far more important part in defining the elderly [8]. In most developed countries, 60 or 65 years is the age of retirement and is therefore often the cutoff for the definition of old age. In contrast, in developing countries, where retirement is less common, social roles and loss of social station due to physical decline play a far more important part in dictating the definition of old age. Therefore, in developing countries, old age commences at the stage of life where one is no longer able to contribute to one’s assigned role in society [9].

Frailty or Biologic Age

In developed countries such as the United States, there has historically been inconsistent correlation between chronologic and physiologic age. Multiple attempts have been made to categorize patients as elderly based not only on their age but also on their functional status. Fried et al. distinguishes between disability, frailty, and comorbidity by defining frailty as a clinical syndrome characterized by multiple factors, including weight loss, fatigue, weakness, low activity level, slow motor performance, balance and gait abnormalities, and cognitive decline [10]. While many studies have attempted to create an index to predict biologic age based on frailty, comorbidity, and disability, none have completely captured the complexity that defines the elderly patient [11]. A study by Jacobs et al. evaluated a large cohort of elderly patients who had a favorable overall health profile at the age of 70 years but had progressive deterioration at the age of 78 years and older and more profoundly so at the age of 85 years and older [12]. As a consequence of these data, many suggest that a cutoff of 70 years of age may be a better definition of the elderly; however, there is still a need for further research to differentiate between the aging process and disease morbidity [13].

Because of the varying perspectives pertaining to the definition of the elderly, most would agree that a simple characterization such as age or functional status does not answer the complex question of the definition of old age. It may be more appropriate to use a combination of age, function, and social definitions.

Demographics of the Aging World

Demography comes from the two Greek words, *dēmos*, which means “the people,” and *graphō*, which means “measurement.” Historically, demography has been defined as the study of

changes in human populations over time [14]. The global population has changed dramatically over the last two centuries as a consequence of demographic transition. This concept, described by Warren Thompson, defines a transition in a population from high birth and death rates to low birth and death rates as a consequence of economic development [15]. Pre-industrialized societies have high birth rates because children can contribute to individual household economy. In these societies, however, mortality remains relatively high. Accordingly, the population of the pre-industrialized society is predominantly young. Conversely, as countries begin to industrialize, death rates decline due to improved health and augmented resources. As a consequence, the populations of industrialized countries grow exponentially. Birth rates eventually decrease in post-industrialized societies given improved access to contraception, urbanization, and literacy and increased rates of employment in women. Subsequently, the age distribution in post-industrialized societies shifts to a predominantly elderly population [16].

Global Aging

According to the UN *World Population Prospects* in 2015, the world population reached 7.3 billion, an increase of nearly 1 billion over the last 12 years [17]. It is estimated that the world population is growing at an average rate of 1.18 percent per year [18]. Population growth has been particularly high in the least developed countries; continents with high fertility rates, such as Africa, have had the highest rate of population growth in the last decade (2.5 percent annually) [17].

Given the increased number of industrialized countries in the world, the population has aged at unprecedented rates. Predictably, over the last 10 years, life expectancy has increased globally by 3 years (from 67 to 70 years). The greatest increase in life expectancy occurred in Africa. However, this increase is still significantly lower than the North American life expectancy (60 versus 79 years) [17]. As a result of increased life expectancy, the population group older than 60 years of age has had the largest annual growth rate at a global level (3.2 percent per year), nearly three times that of the population as a whole [17]. In 2015, the United Nations reported that globally, there were 901 million people older than 60 years of age, which comprised nearly 12 percent of the world population. The United Nations estimates that by 2050, the number of elderly in the world will, for the first time in history, be greater than the number of young individuals.

National Aging

The United States has seen similar changes in the age structure of its population. After World War II, there was a historic increase in the annual birth rate, with 3.4 million babies born in 1946, 20 percent higher than the year before. The sharp increase in the birth rate was maintained for nearly 18 years, until 1964, at which point there had been 76 million babies born [19]. This sharp rise in the American birth rate has been termed the *baby boom*. As a consequence, the age structure of the population has been continuously and drastically shifting. In 2015, the United Nations reported that the median age in the United States was 37 years, seven years higher than that in 1980. It is estimated that the median age will continue to increase to 42 years in 2050. According to the most recent US Census of 2010, the median age in the United States varies substantially based on both geography and gender. Northeastern states have the highest and western states the lowest median age (39.2 versus 35 years, respectively). Women have the highest median age throughout the

country [20]. Accordingly, life expectancy in the United States has increased from 75 years in 1990 to 79 years in 2015.

In contrast, in United States the total fertility rate (average number of children per woman) has been slowly declining. In 2015, the total fertility rate in the United States was 1.9, 8 percent lower than that documented in 2005. It is estimated that the United States has one of the lowest fertility rates in the world [21]. As expected, these data have substantial ramifications for the age distribution. According to the 2010 US Census, the population of Americans under 18 years of age comprised up to 24 percent of the population, with annual growth rates of 2.6 percent per year. In contrast, the 65 years of age and older population comprised only 13 percent of the total population but had a growth rate nearly six times higher than that of the population group younger than 18 years of age [20].

Outcomes and Trends

Many studies have documented the increased prevalence of chronic medical conditions and lower physiologic reserve in the elderly compared with their younger counterparts [22]. The cost of treating chronic conditions is close to five times higher than that of nonchronic illnesses [23]. Kodner et al. suggest that treatment of chronic diseases represents the highest-cost and fastest-growing segment of US healthcare [24]. Multimorbidity, the presence of two or more chronic diseases, is becoming common among the elderly, with a prevalence of 40 to 80 percent, which is eight times higher than the rate seen in the younger than 19 years of age group [25]. Cognitive impairment and cardiovascular disease are the most common disorders among the elderly. In the elderly population, the prevalence of chronic neurologic disorders increases proportionally with age, beyond that seen with cardiovascular disease, with the oldest-old (>85 years of age) having a prevalence of neurologic disorders as high as 36 percent [26]. Many studies have demonstrated that multimorbidity has a substantial impact on mental health, quality of life [27, 28], and overall health outcomes in the elderly population [29]. Multimorbidity in the elderly population has been associated with substantial increases in the risk of mortality, with some studies reporting risks as high as 53 percent [30]. However, more important than comorbidity is the impact of disability on quality of life and mortality among the elderly. According to the most recent CDC estimates, nearly 36 percent of persons older than 65 years of age have evidence of disability [31]. Several studies have demonstrated that disability plays an important role in mortality in the elderly. Landi et al. suggest that the effect of disability on the risk of death was higher than, and independent of, multiple comorbidities. However, the combination of both multiple comorbidities and disability greatly increases the risk of mortality in this population group [32].

Outcomes in Critical Care

The elderly population comprises an increasing proportion of the patients admitted to ICUs. Approximately one-half of all patients admitted to the ICU are over age 65, even though this same age cohort comprises only approximately 12 percent of the population [33]. Despite advances in medical and surgical care, the mortality rate for elderly patients admitted to the ICU is unacceptably high. A study by Tabah et al. demonstrated that the one-year mortality rate was 67 percent in the subgroup of elderly patients being admitted to the ICU for unscheduled surgery [34]. Consistent with these results, de Rooij et al. demonstrated that the one-year mortality rate for both medical and unplanned surgical admissions in the elderly was 89 percent [35].

Equally important is the consideration of how patients who survive their ICU admission will function after discharge. Roch et al. suggest that the two-year mortality rate of patients over 80 years of age who are admitted to the ICU remains unacceptably high compared with the general population. Approximately 50 percent of the elderly discharged from the hospital after their ICU stay were not be alive after two years. Moreover, the physical function and overall health of the survivors were significantly decreased compared with younger populations [36].

Cost of Elderly Healthcare

The ratio of dependent people (children <18 years of age and adults >64 years of age) to 100 working-age people (18 to 64 years of age) is termed the *age-dependency ratio*. This can provide estimates of the economic burden the nonworking population places on the working population. In the United States, the total age-dependency ratio dropped from 2000 to 2010 (61 to 59), signifying that there were 2.7 fewer “dependent-age” people for every 100 working-age people [37]. However, these calculations include both the young and the elderly. The youth age-dependency ratio (<18 years of age) is not expected to increase significantly in the next two decades. However, all the baby boomers will have transitioned to the elderly population over the course of the next two decades. As a consequence, the elderly age-dependency ratio (>64 years of age) is projected to climb rapidly from 22 to 35 in the next two decades [38]. The anticipated increase in the elderly age-dependency ratio is of particular concern in the context of rising healthcare costs in the United States. According to the most recent estimates from the Centers for Medicare and Medicaid Services (CMS), the United States spent nearly \$3 trillion in healthcare expenses in 2014, a historical high. This represents approximately 17.5 percent of the US GDP, higher than for any other country in the world [39].

The elderly use a large portion of the total healthcare expenditure in the United States. This is primarily due to the high hospitalization and institutionalization rate among the elderly. Rice et al. suggest that in any given year, 20 percent of the elderly will be hospitalized, and almost a quarter of the elderly will become institutionalized in a nursing home during their lifetimes [40]. According to the CDC, close to 96 percent of the elderly population incurs some healthcare expense every year. CMS estimated that in 2010, the healthcare spending for people older than 64 years of age was \$18,424 per person, which is five times higher than the spending per child (\$3,628) and three times higher than the spending per working-age person (\$6,125) [41].

The increases in healthcare spending increase proportionally with age, nearly doubling between 70 and 90 years of age and peaking at age 96 before tapering off. The mean Medicare spending per person in 2011 was more than double for individuals 96 years of age compared with those 70 years of age (\$16,145 versus \$7,566, respectively) [42]. Among the elderly, the oldest-old (those ≥80 years of age) comprised 24 percent of the Medicare population and up to a third of total Medicare spending. In contrast, the younger elderly (aged 65 to 69 years) comprised 26 percent of the Medicare population and only 15 percent of Medicare spending [43]. These spending patterns are of particular concern given the disproportionate growth of the oldest-old. It is estimated that from 2010 to 2050, the US population aged 65 and older will nearly double, but the population aged 80 and older will triple [44].

Assuming no drastic changes in the mortality rate of the elderly, it is uniformly accepted that the total cost of healthcare for the elderly will continue to increase. The Agency for Healthcare Research and Quality (AHRQ) estimated that the total healthcare expenses for the elderly in 2011 were \$414.3 billion, which was over \$100 billion higher than inflation-adjusted expenses for 2001 [45].

The demographic transition that began in both the United States and the world in the nineteenth century continues to have an impact on the age structure of the world. The increasing life expectancy and decreasing fertility rates have drastically modified the age distribution of all countries. The unprecedented reversal in the proportion of young and older population groups will continue to have significant ramifications for healthcare spending and the economies of both developing and developed countries.

Areas of Opportunity for Improvement

Given the staggering statistics regarding the increased numbers of the aging population, it is important for the medical community to focus efforts on improving healthcare for the elderly. Some of the promising areas of opportunity for improvement include awareness and education, studies to define and stratify the elderly more precisely, and a changing focus from survival to mitigation of cognitive impairment, improvement in quality of life, and increases in functional autonomy.

Currently, there is a paucity of data on clinical outcomes in very elderly population (>80 years of age) because many of the previous studies have categorized the elderly as anyone over the age of 65. Many new studies, however, now focus attention on the stratification of age and the difference in needs and outcomes for those individuals who are *extremely elderly*, the *very elderly*, and the *eldest elderly*. The exact ages at which these terms are used varies by study and may apply to individuals older than 70 to 90 years of age [46]. As the population continues to age, it will become increasingly important to define the extreme elderly and to focus research on the specific medical needs and prognoses of this population.

Another area of opportunity for improvement is in the culture of clinical practice, where the focus has traditionally been on improving disease-specific outcomes. Much improvement and data are needed to encourage the shift of focus to overall and long-term goals. As mentioned earlier, mortality for older patients after discharge from the hospital is substantial, and morbidity of the survivors is unacceptably high. Several studies have emphasized the importance of counseling to help prepare patients and families for the difficulties they will face once patients leave the hospital [36]. Equally important is education and preparation for end-of-life discussions in this high-risk group. Literature is emerging to develop guidelines to identify patients who benefit most from palliative care services in the ICU [47]. It will become increasingly important to identify the best approach to provide multidisciplinary care ranging from surgical and critical care to palliative care in a manner that enhances communication and achieves desired outcomes.

Conclusion

The aging of the population in the United States and worldwide will have a substantial impact on healthcare and will create many new challenges and opportunities for medical professionals. The medical community must embrace the changing demographics of our patient populations and focus our efforts not only on improving the life expectancy of our patients but also on improving the quality of life and care, especially for those in the later decades of

life. We look forward to the growing body of literature focused on the older population, which will allow us to better understand the very specific needs and concerns of this unique population. It is important to remember that most persons will at some point become elderly, and clinicians should embrace the mentality espoused by Tia Walker in her book about caregivers, “[t]o care for those who once cared for us is one of the highest honors” [48].

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