Cancer Statistics for Adults Aged 85 Years and Older, 2019

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Abstract: Adults aged 85 years and older, the “oldest old,” are the fastest-growing age group in the United States, yet relatively little is known about their cancer burden. Combining data from the National Cancer Institute, the North American Association of Central Cancer Registries, and the National Center for Health Statistics, the authors provide comprehensive information on cancer occurrence in adults aged 85 years and older. In 2019, there will be approximately 140,690 cancer cases diagnosed and 103,250 cancer deaths among the oldest old in the United States. The most common cancers in these individuals (lung, breast, prostate, and colorectum) are the same as those in the general population. Overall cancer incidence rates peaked in the oldest men and women around 1990 and have subsequently declined, with the pace accelerating during the past decade. These trends largely reflect declines in cancers of the prostate and colorectum and, more recently, cancers of the lung among men and the breast among women. We note differences in trends for some cancers in the oldest age group (eg, lung cancer and melanoma) compared with adults aged 65 to 84 years, which reflect elevated risks in the oldest generations. In addition, cancers in the oldest old are often more advanced at diagnosis. For example, breast and colorectal cancers diagnosed in patients aged 85 years and older are about 10% less likely to be diagnosed at a local stage compared with those diagnosed in patients aged 65 to 84 years. Patients with cancer who are aged 85 years and older have the lowest relative survival of any age group, with the largest disparities noted when cancer is diagnosed at advanced stages. They are also less likely to receive surgical treatment for their cancers; only 65% of breast cancer patients aged 85 years and older received surgery compared with 89% of those aged 65 to 84 years. This difference may reflect the complexities of treating older patients, including the presence of multiple comorbidities, functional declines, and cognitive impairment, as well as competing mortality risks and undertreatment. More research on cancer in the oldest Americans is needed to improve outcomes and anticipate the complex health care needs of this rapidly growing population.

Keywords: cancer statistics, geriatrics, incidence, mortality, screening

Introduction

Adults aged 85 years and older, sometimes referred to as the “oldest old,” are the fastest-growing age group in the United States. The number of adults aged 85 years and older is expected to nearly triple from 6.4 million in 2016 to 19.0 million by 2060, primarily fueled by increasing life expectancy from declines in all-cause mortality because of less smoking, improved screening, and treatment advances. Factors that threaten to slow or even reverse this progress include the obesity epidemic and persistent socioeconomic inequalities.

Women outnumber men in the oldest age group because of their longer life expectancy; in 2016, there were 4.2 million women aged 85 years and older compared with 2.2 million men, or 186 women for every 100 men. However, the lag in the tobacco epidemic in women compared with men (ie, both the later uptake of smoking in large numbers and the delay in smoking cessation) is expected to narrow the sex gap in life expectancy. For example, by 2030, remaining life expectancy at
age 65 years is projected to increase by 2 years in men but by only 1 year in women. Furthermore, growth of the racial/ethnic minority and foreign-born populations will lead to increasing diversity over the next several decades in the oldest old age group. Among persons aged 85 years and older, the proportion of non-Hispanic whites (whites) is predicted to decline from 84% in 2012 to 61% in 2060.

Despite the increasing numbers and changing profile of this population, relatively little is known about the cancer burden in this age group. Knowledge regarding appropriate treatments and the complex health care needs of older patients with cancer is limited because of underrepresentation of this population in clinical research. Diagnosis and treatment of cancer at older ages are often complicated by comorbidities, cognitive impairment, frailty, functional losses, social isolation, and other factors. In this report, we provide information on cancer in those aged 85 years and older in the United States, including data on incidence, mortality, survival, treatment, and screening, and we discuss some of the unique challenges affecting these patients.

Materials and Methods

Data Sources

Population-based cancer incidence data in the United States are collected by the National Cancer Institute’s (NCI’s) Surveillance, Epidemiology, and End Results (SEER) program and the Centers for Disease Control and Prevention’s National Program of Cancer Registries. Historical incidence trends (1975-2015) for adults aged 85 years and older were based on data from the 9 oldest SEER registries, representing 9% of the US population. Data from the 18 SEER registries, covering 28% of the US population, were used in analyses of age-specific incidence rates (up to age 95 years and older), 5-year relative survival rates, and receipt of surgical treatment in the most recent time period (2011-2015). Combined SEER and National Program of Cancer Registries data, as provided by the North American Association of Central Cancer Registries (NAACCR), were the source of data for the most recent (2011-2015) incidence rates, the distribution of cases by stage at diagnosis, and analyses of incidence trends in 2 older age groups (ages 65-84 years and 85 years and older) for selected sites during 1995 to 2015. Data for the most recent time period reflect 96% coverage of the US population, excluding data from 4 states (Kansas, Minnesota, Nevada, and New Mexico) and the District of Columbia because these registries did not submit data or failed to meet NAACCR quality standards for all years from 2011 through 2015. Analyses of incidence trends from 1995 through 2015 were based on data from 28 states covering 66% of the US population because data from 18 additional states (Arkansas, Georgia, Indiana, Maryland, Massachusetts, Mississippi, Missouri, Montana, New York, North Dakota, Ohio, Oklahoma, Oregon, South Carolina, South Dakota, Tennessee, Vermont, and Virginia) were not available for all years during the study period. Mortality data obtained from the National Center for Health Statistics covering all 50 states and the District of Columbia, as reported for the SEER program, were the source for death rates in the most recent time period (2012-2016) and for long-term trends (1976-2016). Incidence and mortality rates for American Indians/Alaska Natives were based on cases/deaths in the Contract Health Service Delivery Area counties. The 2015 National Health Interview Survey was used for estimates of cancer screening prevalence. The estimated number of cancer survivors aged 85 years and older was obtained through personal communication with the authors of the report, “Anticipating the Silver Tsunami.”

Statistical Analyses

Case estimates for men and women aged 85 years and older were calculated by applying the proportion of cases in this age group diagnosed during 2011 through 2015 from the NAACCR analytic file to the previously published total number of estimated cases for each cancer site in males and females in 2019. Similarly, we calculated the estimated number of cancer deaths in patients aged 85 years and older by applying the proportion of deaths in that age group during 2012 through 2016 to the total estimated deaths for each site in 2019.

Incidence and death rates were age standardized to the 2000 US standard population and are expressed per 100,000 population. In analyses of incidence trends for selected sites using NAACCR data, we applied delay adjustment factors developed for the SEER 18 registries to account for delays in reporting. All cancer cases were classified according to the International Classification of Diseases for Oncology. Causes of death were classified according to the International Statistical Classification of Diseases and Related Health Problems. The probability of developing cancer was calculated using the NCI’s DevCan software (version 6.7.6). All cancer cases and deaths were accessed using SEER*Stat software (version 8.3.5). The annual percent change in rates was quantified using the NCI’s Joinpoint Regression Program (version 4.6.0.0). Screening estimates were calculated using SAS-callable SUDAAN (version 11.0.1; RTI International, Research Triangle Park, North Carolina) and accounted for the complex survey design.

Selected Findings

Incidence

Adults aged 85 years and older represent 2% of the US population but 8% of all new cancer diagnoses, translating to
approximately 140,690 new cases diagnosed in 2019 (61,830 male and 78,860 female cases). Among adults in this age group without a history of a cancer, the risk of an invasive cancer diagnosis (excluding nonmelanoma skin cancers) in their remaining lifetime is 16.4% for men and 12.8% for women. Overall cancer risk increases with age until approximately ages 80 to 84 years in women and ages 85 to 89 years in men (Fig. 1), reflecting lifetime accumulation of carcinogenic exposures (eg, cigarette smoking, excess body weight, alcohol consumption) and somatic mutations, as well as age-related changes to the immune system.25-27

Reasons for the subsequent decline in risk beyond those ages are unclear28-30 but may reflect lower genetic susceptibility or the consequences of the natural aging process that inhibit tumor growth. For example, one theory suggests that the remodeling of the immune system among the very old, including increases in certain T cells and natural killer cells, creates a hostile environment for cancer growth.34 Cellular senescence may also play a role, although this process can both inhibit and promote carcinogenesis.27,31,33 In addition, autopsy studies often report undiagnosed cancer in this age group, and therefore lower incidence rates likely reflect undetected cancer to some extent because of the less intensive use of diagnostic testing and screening.35 Notably, however, incidence rates continue increasing through age 95 years and older for some cancers, including those of the colorectum, pancreas, stomach, and urinary bladder, as well as leukemia and skin melanoma.16,37

The most commonly diagnosed cancers are lung (16%), prostate (13%), and urinary bladder (13%) in the oldest old men and breast (19%), colorectum (14%), and lung (14%) in the oldest old women (Table 1). The top 10 cancers in men and women aged 85 years and older are similar to those for all ages combined with a few exceptions (eg, the inclusion of cancers of the stomach in men and of the urinary bladder and ovary in women).18

Mortality
Cancer is the second leading cause of death, after heart disease, in this population, with approximately 103,250 cancer deaths expected in 2019 (49,040 male and 54,210 female deaths), accounting for 17% of all cancer deaths. The remaining lifetime risk of cancer death for adults aged 85 years or older is 14.4% for men and 9.6% for women. The leading causes of cancer death in the oldest old parallel those for all ages. Among men aged 85 years and older, prostate and lung cancers are the most common causes of cancer death, together representing 40% of cancer deaths. Among women, lung cancer is the leading cause of cancer death (19%) followed by breast cancer (13%) (Table 1). For men and women, colorectal cancer is the third leading cause of cancer death, representing 9% and 12% of cancer deaths, respectively.

Racial/Ethnic Variation in Rates
Cancer incidence and mortality rates by race/ethnicity for persons aged 85 years and older are shown in Figure 2. Among the oldest old women, American Indians/Alaska Natives have the highest cancer incidence rate, reflecting their high burden of lung and colorectal cancers, and Asians/Pacific Islanders have the lowest rate. Among the oldest old men, the cancer incidence rate is highest in whites and lowest among Asians/Pacific Islanders. The overall cancer incidence rate is 16% higher in white men than in non-Hispanic black (black) men, who have the second highest rate, largely driven by higher rates of urinary bladder cancer, melanoma, and non-Hodgkin lymphoma. This pattern differs in younger men (aged 45-74 years) and men of all ages combined, among whom rates are higher in blacks than whites. For example, among men aged 50 to 64 years, the incidence rate is 30% higher in black men compared with white men.34

Cancer mortality patterns differ from those for incidence, especially in men. Black men have a 5% higher cancer
mortality rate than white men despite their lower incidence rate (Fig. 2), reflecting the persistence of racial/ethnic disparities in stage at diagnosis and survival. Although racial differences in stage at diagnosis for the oldest old are generally smaller than those observed in the general population, survival differences are still striking. For example, 5-year relative survival rates for patients aged 85 years and older with either local-stage or regional-stage lung cancer are about 3 times higher in whites compared with blacks. This disparity may reflect inequalities in access to and receipt of quality medical care and differences in the burden of comorbidities and other age-associated conditions. Despite relatively universal access to basic health insurance through Medicare, some costs of cancer care are not fully covered by Medicare and can be burdensome for older patients with limited, fixed incomes. Importantly, growth of the racial/ethnic minority population at highest mortality risk will lead to increasing diversity over the next several decades in the oldest old age group. As the Baby Boomer population enters the oldest age groups, the proportion of whites aged 85 years and older is expected to decline from 84% in 2012 to 61% in 2060. This will challenge the health care system to provide culturally competent services to meet the unique needs of an increasingly diverse older population.

### TABLE 1. Leading Sites of New Cancer Cases and Deaths, Ages 85 Years and Older, United States

#### INCIDENCE

| MALES | ESTIMATED CASES, 2019 | | FEMALES | ESTIMATED CASES, 2019 | |
|-------|-----------------------|---|---------------------|---------------------|
|       | NO.  | %   | RATE, 2011-2015 | NO.  | %   | RATE, 2011-2015 |
| 1. Lung & bronchus | 9,800 | 16% | 450.6 | 1. Breast | 14,800 | 19% | 332.8 |
| 2. Prostate | 7,960 | 13% | 366.0 | 2. Colon & rectum | 11,200 | 14% | 252.0 |
| 3. Urinary bladder | 7,870 | 13% | 361.7 | 3. Lung & bronchus | 10,870 | 14% | 244.4 |
| 4. Colon & rectum | 6,640 | 11% | 305.2 | 4. Pancreas | 4,150 | 5% | 93.4 |
| 5. Melanoma of the skin | 4,000 | 6% | 183.9 | 5. Non-Hodgkin lymphoma | 3,710 | 5% | 83.5 |
| 6. Non-Hodgkin lymphoma | 3,090 | 5% | 142.1 | 6. Urinary bladder | 3,360 | 4% | 75.5 |
| 7. Leukemia | 2,740 | 4% | 126.0 | 7. Leukemia | 3,000 | 4% | 67.6 |
| 8. Pancreas | 2,270 | 4% | 104.1 | 8. Melanoma of the skin | 2,510 | 3% | 56.5 |
| 9. Kidney & renal pelvis | 1,730 | 3% | 79.6 | 9. Uterine corpus | 2,310 | 3% | 51.9 |
| 10. Stomach | 1,390 | 2% | 63.8 | 10. Ovary | 1,900 | 2% | 42.7 |
| All sites | 61,830 | 100% | | | 78,860 | 100% | |

#### MORTALITY

| MALES | ESTIMATED DEATHS, 2019 | | FEMALES | ESTIMATED DEATHS, 2019 | |
|-------|-----------------------|---|---------------------|---------------------|
|       | NO.  | %   | RATE, 2012-2016 | NO.  | %   | RATE, 2012-2016 |
| 1. Prostate | 9,860 | 20% | 452.9 | 1. Lung & bronchus | 10,200 | 19% | 247.8 |
| 2. Lung & bronchus | 9,700 | 20% | 445.6 | 2. Breast | 7,150 | 13% | 173.7 |
| 3. Colon & rectum | 4,380 | 9% | 201.1 | 3. Colon & rectum | 6,740 | 12% | 163.7 |
| 4. Urinary bladder | 3,410 | 7% | 156.9 | 4. Pancreas | 4,210 | 8% | 102.2 |
| 5. Leukemia | 2,590 | 5% | 119.2 | 5. Leukemia | 2,630 | 5% | 63.8 |
| 6. Pancreas | 2,530 | 5% | 116.4 | 6. Non-Hodgkin lymphoma | 2,570 | 5% | 62.4 |
| 7. Non-Hodgkin lymphoma | 2,160 | 4% | 99.4 | 7. Ovary | 2,060 | 4% | 50.1 |
| 8. Liver & intrahepatic bile duct | 1,230 | 3% | 56.6 | 8. Urinary bladder | 1,680 | 3% | 40.7 |
| 9. Kidney & renal pelvis | 1,200 | 2% | 55.1 | 9. Liver & intrahepatic bile duct | 1,380 | 3% | 33.4 |
| 10. Esophagus | 1,120 | 2% | 51.4 | 10. Uterine corpus | 1,330 | 2% | 32.4 |
| All sites | 49,040 | 100% | | All sites | 54,210 | 100% | |

Rates are per 100,000 population.
Cancer Statistics for Adults 85 & Older

**Incidence**

The overall cancer incidence rate has decreased in the oldest old men since about 1990 (Fig. 3), reflecting sharp declines in incidence rates for cancers of the prostate, colorectum, and, more recently, lung (Fig. 4) (Table 2). The lung cancer pattern differs in older men compared with younger men; the incidence rate peaked around 2003 among men aged 85 years and older compared with a peak in the mid-1980s among men aged 65 to 84 years. The delayed decline in the oldest old men primarily reflects generational differences in smoking patterns. Men born circa 1920 (who entered the group aged 85 years and older in 2005) had the highest smoking rates of any birth cohort, with the peak smoking prevalence exceeding 70% during the 1950s. As younger generations with lower smoking rates enter the oldest age group, lung cancer rates will likely continue to decline. In contrast, the decline in the prostate cancer incidence rate has been more rapid in men aged 85 years and older compared with younger men. Before 2009, prostate cancer was the most common cancer in this age group (Fig. 4). This shift is due primarily to rapid declines in prostate cancer incidence over the last several decades, likely from prostate cancers being diagnosed at earlier ages through prostate-specific antigen (PSA) testing. The decrease in the colorectal cancer incidence rate since 2000 has been similar among men aged 65 to 84 years of age and those aged 85 years and older and largely reflects the increased use of colonoscopy among younger age groups, which allows for the removal of premalignant lesions. In contrast, melanoma incidence has increased more rapidly over the past several decades in the oldest old men (4.3% per year during 2002-2015 vs 3.4% per year in men aged 65-84 years), which is also thought to be a birth cohort effect reflecting excessive sun exposure among children during the early part of the 20th century. Melanoma is predicted to become the second most commonly diagnosed cancer among men aged 85 years and older by 2030. Interestingly, although melanoma incidence rates are higher in women before age 50 years, men have higher rates at older ages, with rates 3 times higher among men in those aged 85 years and older.

Among women aged 85 years and older, the overall cancer incidence rate peaked around 1990 before subsequently decreasing (Fig. 3), with an acceleration in the decline after 2009, largely reflecting declining rates for breast and colorectal cancers (Fig. 4) (Table 2). This is in contrast to trends in women aged 65 to 84 years, among whom the overall rate peaked in the late 1990s. Although the breast cancer in this age group (Fig. 4). This shift is due primarily to rapid declines in prostate cancer incidence over the last several decades, likely from prostate cancers being diagnosed at earlier ages through prostate-specific antigen (PSA) testing. The decrease in the colorectal cancer incidence rate since 2000 has been similar among men aged 65 to 84 years of age and those aged 85 years and older and largely reflects the increased use of colonoscopy among younger age groups, which allows for the removal of premalignant lesions. In contrast, melanoma incidence has increased more rapidly over the past several decades in the oldest old men (4.3% per year during 2002-2015 vs 3.4% per year in men aged 65-84 years), which is also thought to be a birth cohort effect reflecting excessive sun exposure among children during the early part of the 20th century. Melanoma is predicted to become the second most commonly diagnosed cancer among men aged 85 years and older by 2030. Interestingly, although melanoma incidence rates are higher in women before age 50 years, men have higher rates at older ages, with rates 3 times higher among men in those aged 85 years and older.

**Mortality**

FIGURE 2. Cancer Incidence and Mortality Rates Among Adults Aged 85 Years and Older by Race/Ethnicity, United States, 2011 to 2016. NH indicates non-Hispanic.
cancer rate has increased slightly among women aged 65 to 84 years since 2004, the rate has continued to decline in the oldest age group (2.1% per year since 2009). Breast cancer surpassed colorectal cancer in 2005 as the most commonly diagnosed cancer in the oldest old women because of a steeper decline in the colorectal cancer incidence rate (Fig. 4). Similar to men, generational differences in smoking among women are reflected in lung cancer incidence trends. The decline in lung cancer incidence rates began earlier in women aged 65 to 84 years compared with those aged 85 years and older. Although the pancreatic cancer rate continues to increase in women aged 65 to 84 years, the incidence rate has leveled off in women aged 85 years and older since 2008. Similar to men, the melanoma incidence rate has increased more rapidly among the oldest old women, by 3.7% per year from 2000 to 2015 versus 3.1%.

Mortality
Among women aged 85 years and older, the overall cancer death rate increased until the early 2000s and has since declined by 0.8% per year (Fig. 3). The overall pattern reflects decreasing death rates for cancers of the colorectum and breast that were partly offset by the increasing death rate for lung cancer through the early 2000s (Fig. 5). The lung cancer death rate in the oldest old women increased nearly 4-fold (from 66 deaths per 100,000 population in 1975 to 244 deaths per 100,000 population in 2006) and then stabilized through 2016. In contrast, among women aged 65 to 84 years, the lung cancer death rate has decreased since the mid-2000s (Table 3). Before the mid-2000s, colorectal cancer was the leading cause of cancer death in the oldest women. However, since the mid-1980s, the colorectal cancer death rate has declined rapidly and, as of 2010, colorectal cancer dropped to the third leading cause of cancer death. The breast cancer death rate has also declined by approximately 0.9% per year since its peak in the mid-1990s. In contrast, death rates in the oldest old women have increased for melanoma and pancreatic cancer since at least 1975.

The overall cancer death rate peaked in men aged 85 years and older in the mid-1990s and has declined by 1.4% per year over the past decade (Fig. 3). This trend largely reflects patterns in lung and prostate cancer (Fig. 5). The prostate cancer death rate in men increased sharply until 1993, then dropped precipitously until plateauing during 2014 through 2016 at a slightly lower rate than observed in 1975. Reasons for the sharp increase in the prostate cancer death rate in the oldest old men are not known but are thought to be because of misclassification of deaths from other causes on death certificates because of the rapid rise in disease prevalence after the introduction of widespread PSA testing.48 The subsequent decline in the death rate likely results from earlier detection and improvements in treatment of advanced disease,49,50 but it remains unclear why the overall rate in men has recently plateaued.51 Declines in death rates for lung and colorectal cancers are similar to incidence patterns over the past 2 decades. Notably, urinary bladder cancer death rates have increased in the oldest old men by 1% per year from 2000 to 2016, whereas rates have declined in men aged 65 to 84 years since the late 1970s. Reasons for the divergent pattern are not known, but are perhaps...
because of the increase in incidence rates through 2008 that was limited to the oldest old men. The death rate has also increased for pancreatic cancer (0.3% per year since 1975). In contrast, death rates for melanoma finally stabilized in 2009 after rapidly increasing (3.3% annually) during the previous 3 decades.

### Stage at Diagnosis

Patients aged 85 years and older with cancer are less likely to be diagnosed at an early stage of disease than those aged 65 to 84 years (Fig. 6). For example, among the oldest old, 57% of patients with breast cancer and 41% of patients with prostate cancer are diagnosed at a local stage, compared with 68% and 77% of patients aged 65 to 84 years, respectively. Late stage at diagnosis among the oldest old partly reflects less screening. Importantly, the oldest old patients are 2 to 4 times more likely to lack staging information in medical records than those aged 65 to 84 years (Fig. 6). This may be because older patients do not undergo complete diagnostic testing due to

### Table 2. Joinpoint Trends in Cancer Incidence Rates for Selected Sites in 2 Age Groups, United States, 1995 to 2015

|                | TREND 1 | TREND 2 | TREND 3 | TREND 4 |
|----------------|---------|---------|---------|---------|
|                | YEARS   | APC     | YEARS   | APC     | YEARS   | APC     | YEARS   | APC     |
| **MALES**      |         |         |         |         |         |         |         |         |
| Colon & rectum |         |         |         |         |         |         |         |         |
| 65-84 y        | 1995-2000 | 0.0     | 2000-2015 | −4.2*  |         |         |         |         |
| ≥85 y          | 1995-2000 | −0.5    | 2000-2015 | −4.4*  |         |         |         |         |
| Lung & bronchus |         |         |         |         |         |         |         |         |
| 65-84 y        | 1995-2008 | −1.2*   | 2008-2015 | −2.8*  |         |         |         |         |
| ≥85 y          | 1995-2008 | 0.0     | 2008-2015 | −2.1*  |         |         |         |         |
| Melanoma of the skin |         |         |         |         |         |         |         |         |
| 65-84 y        | 1995-2000 | 5.5*    | 2000-2015 | 3.4*   |         |         |         |         |
| ≥85 y          | 1995-2002 | 7.4*    | 2002-2015 | 4.3*   |         |         |         |         |
| Prostate       |         |         |         |         |         |         |         |         |
| 65-84 y        | 1995-2001 | 0.9     | 2001-2004 | −5.7   | 2004-2007 | 2.0     | 2007-2015 | −6.7*  |
| ≥85 y          | 1995-2003 | −3.0*   | 2003-2015 | −6.7*  |         |         |         |         |
| Urinary bladder |         |         |         |         |         |         |         |         |
| 65-84 y        | 1995-1998 | 1.9*    | 1998-2005 | 0.2    | 2005-2013 | −0.9*   | 2013-2015 | −3.3*  |
| ≥85 y          | 1995-2008 | 1.2*    | 2008-2015 | −0.9*  |         |         |         |         |
| **FEMALES**    |         |         |         |         |         |         |         |         |
| Breast         |         |         |         |         |         |         |         |         |
| 65-84 y        | 1995-1999 | 1.6*    | 1999-2004 | −2.7*  | 2004-2015 | 0.8*    |         |         |
| ≥85 y          | 1995-1999 | 1.9*    | 1999-2003 | −3.6*  | 2003-2009 | 0.1     | 2009-2015 | −2.1*  |
| Colon & rectum |         |         |         |         |         |         |         |         |
| 65-84 y        | 1995-1998 | 1.5*    | 1998-2005 | −2.7*  | 2005-2015 | −4.3*   |         |         |
| ≥85 y          | 1995-1998 | 1.7     | 1998-2008 | −3.0*  | 2008-2015 | −5.0*   |         |         |
| Lung & bronchus |         |         |         |         |         |         |         |         |
| 65-84 y        | 1995-1997 | 2.4*    | 1997-2007 | 1.1*   | 2007-2015 | −1.2*   |         |         |
| ≥85 y          | 1995-2008 | 3.0*    | 2008-2015 | −1.2*  |         |         |         |         |
| Melanoma of the skin |         |         |         |         |         |         |         |         |
| 65-84 y        | 1995-2000 | 5.1*    | 2000-2015 | 3.1*   |         |         |         |         |
| ≥85 y          | 1995-2015 | 3.7*    |         |         |         |         |         |         |
| Pancreas       |         |         |         |         |         |         |         |         |
| 65-84 y        | 1995-2015 | 0.8*    |         |         |         |         |         |         |
| ≥85 y          | 1995-2008 | 0.8*    | 2008-2015 | −0.7   |         |         |         |         |

Abbreviation: APC, annual percent change.
Note: Rates have been adjusted for reporting delays using delay ratios from Surveillance, Epidemiology, and End Results 18 registries.
*Indicates APC is significantly different from zero (P < .05).
other health conditions or preferences. However, staging information is important for the provision of appropriate treatment, regardless of age.

**Cancer Screening**

Routine cancer screening is generally not recommended for those aged 85 years and older because of diminished life expectancy, the higher prevalence of comorbid conditions, and limited evidence of survival benefit, partly because this population has not been included in clinical trials evaluating screening. For most individuals in this age group, the small potential benefit of extending life is likely outweighed by the possible harms from screening, which are more common with increasing age. Harms include additional invasive testing (eg, biopsies), emotional stress (eg, anxiety), overtreatment of nonaggressive tumors, and excessive financial and time burdens on older patients as well as their spouses and family members.52-54 One study found that, after a screening colonoscopy, adults aged 85 years and older were more than twice as likely to experience a serious gastrointestinal event, such as perforation or bleeding, compared with adults aged 66 to 69 years (12 vs 5 events per 1000 colonoscopies, respectively).55 Additional considerations for the oldest adults are higher rates of indolent tumors that would not lead to morbidity or mortality because of competing risks.54 Moreover, the benefits of screening are accrued over time in the form of improved survival from earlier diagnosis and treatment, whereas the risks are often more immediate. It is estimated that there is a 10-year delay to save 1 life per 1000 people screened for breast or colorectal cancer and an even greater delay for prostate cancer.52,56 As a consequence, the benefit of screening is substantially reduced in those with a limited life expectancy. For example, most of those living in long-term residential care facilities (ie, nursing homes) are unlikely to benefit from cancer screening because of limited life expectancy (often fewer than 5 years) and multiple functional deficits that would preclude their ability to undergo cancer treatment.57 It is therefore especially important when considering cancer screening in older adults to assess current health status.

Accurately assessing life expectancy and communicating this information to patients can be challenging. Mortality indexes, such as the Schonberg or Lee indices, which incorporate comorbid conditions, health status, and functional status along with age, can help clinicians estimate life expectancy and guide cancer screening and treatment decisions.58,59 ePrognoxis (eprognosis.ucsf.edu) is an online repository of validated tools for estimating remaining life expectancy among older persons in various settings and also provides helpful information to guide prognosis communication.60 A recent study of adults aged 65 years and older reported that, although older adults were amenable to using age and health status within the context of discussing screening cessation, there were concerns with discussions overly focused on life expectancy.61 Another study found that patients prefer clinicians to frame the decision to stop screening in terms of prioritizing other health issues.62 As in all interactions between providers and patients, an informed, shared decision with clear communication of the risks and benefits of cancer screening or treatment should be the centerpiece of clinical care.
Although most guidelines generally recommend against cancer screening in those with less than a 10-year life expectancy, differences across organizations can complicate decisions for patients and their providers. For breast cancer screening, the American Cancer Society (ACS) recommends mammography for all women with a life expectancy of at least 10 years.63 The US Preventive Services Task Force also endorses individualized breast cancer screening.

### TABLE 3. Joinpoint Trends in Cancer Mortality Rates for Selected Sites in 2 Age Groups, United States, 1975 to 2016

|               | TREND 1 | TREND 2 | TREND 3 | TREND 4 | TREND 5 | TREND 6 |
|---------------|---------|---------|---------|---------|---------|---------|
|               | YEARS   | APC     | YEARS   | APC     | YEARS   | APC     | YEARS   | APC     |
| **MALES**     |         |         |         |         |         |         |         |         |
| Colon & rectum| 65-84 y | 1975-1985 -0.2  | 1985-2000 -2.1* | 2000-2016 -3.5* | 2000-2016 -3.2* | 2001-2016 -3.4* |
|               | ≥85 y   | 1975-1978 3.9* | 1978-1991 0.3 | 1991-2001 -1.8* | 2001-2016 -3.2* |         |         |         |
| Lung & bronchus| 65-84 y | 1975-1983 2.2* | 1983-1991 0.7* | 1991-1997 -1.0* | 1997-2005 -1.7* | 2005-2011 -2.7* | 2011-2016 -4.3* | 2011-2016 -4.3* |
|               | ≥85 y   | 1975-1981 5.3* | 1981-1991 2.9* | 1991-1997 0.5 | 1997-2008 -0.6* | 2008-2013 -1.7* | 2013-2016 -3.2* | 2013-2016 -3.2* |
| Melanoma of the skin | 65-84 y | 1975-1987 4.1* | 1987-1998 2.3* | 1998-2001 1.4 | 2001-2010 2.0 | 2010-2014 -1.6 | 2014-2016 -9.0* | 2014-2016 -9.0* |
|               | ≥85 y   | 1975-2009 3.3* | 2009-2016 -0.3 |         |         |         |         |         |
| Pancreas      | 65-84 y | 1975-1988 -0.9* | 1988-1991 1.3 | 1991-1995 -1.5* | 1995-2016 0.3* |         |         |         |
|               | ≥85 y   | 1975-2016 0.3* |         |         |         |         |         |         |
| Prostate      | 65-84 y | 1975-1987 0.6* | 1987-1991 2.6* | 1991-1994 1.8 | 1994-2003 -4.6* | 2003-2013 -3.6* | 2013-2016 0.3 | 2013-2016 0.3 |
|               | ≥85 y   | 1975-1978 4.2* | 1978-1987 1.3* | 1987-1993 4.3* | 1993-2002 -2.2* | 2002-2014 -3.5* | 2014-2016 0.7 | 2014-2016 0.7 |
| Urinary bladder | 65-84 y | 1975-1977 0.0 | 1977-1987 -2.4* | 1987-2000 -0.6* | 2000-2013 -0.2* | 2013-2016 -1.7* |         |         |
|               | ≥85 y   | 1975-1984 1.1* | 1984-1987 -4.9 | 1987-1992 2.0 | 1992-2000 -0.2 | 2000-2016 1.0* |         |         |
| **FEMALES**   |         |         |         |         |         |         |         |         |
| Breast        | 65-84 y | 1975-1990 1.0* | 1990-1994 -0.8 | 1994-1997 -3.5* | 1997-2016 -1.6* |         |         |         |
|               | ≥85 y   | 1975-1996 1.0* | 1996-2016 -0.9* |         |         |         |         |         |
| Colon & rectum| 65-84 y | 1975-1982 -0.8* | 1982-2001 -2.0* | 2001-2016 -3.4* |         |         |         |         |
|               | ≥85 y   | 1975-1984 0.5* | 1984-2001 -1.0* | 2001-2016 -3.1* |         |         |         |         |
| Lung & bronchus| 65-84 y | 1975-1983 8.2* | 1983-1990 6.1* | 1990-1995 3.4* | 1995-2003 1.0* | 2003-2010 -0.8* | 2010-2016 -3.0* | 2010-2016 -3.0* |
|               | ≥85 y   | 1975-1985 4.3* | 1985-1995 5.8* | 1995-2006 3.0* | 2006-2016 -0.1 |         |         |         |
| Melanoma of the skin | 65-84 y | 1975-2006 0.9* | 2006-2016 -1.7* |         |         |         |         |         |
|               | ≥85 y   | 1975-2016 1.3* |         |         |         |         |         |         |
| Pancreas      | 65-84 y | 1975-1993 0.6* | 1993-1997 -0.9 | 1997-2008 0.5* | 2008-2016 -0.1 |         |         |         |
|               | ≥85 y   | 1975-1990 1.8* | 1990-2016 0.4* |         |         |         |         |         |
| Urinary bladder | 65-84 y | 1975-1986 -1.7* | 1986-2016 -0.5* |         |         |         |         |         |
|               | ≥85 y   | 1975-1978 2.9 | 1978-1984 -1.9* | 1984-2014 -0.3* | 2014-2016 2.5 |         |         |         |

Abbreviation: APC, annual percent change.
*Indicates APC is significantly different from zero ($P < .05$).
decisions but highlights the lack of evidence for screening in women older than 75 years. Both of these organizations recommend individualized colorectal cancer screening decisions for adults aged 76 to 85 years and discourage screening after age 85 years. For prostate cancer, the ACS guideline recommends an informed decision-making process to guide prostate cancer testing in men with at least a 10-year life expectancy, and the US Preventive Services Task Force recommends against PSA testing in all men aged 70 years and older. Cervical cancer screening is not recommended by any organization for women older than 65 years among those who have had adequate prior screening, and the US Preventive Services Task Force’s upper age limit for lung cancer screening among heavy current and former (quit within the previous 15 years) smokers is age 80 years (the ACS guideline is age 74 years). The American Geriatrics Society, conversely, recommends a consideration of life expectancy and the risks of testing, overdiagnosis, and overtreatment in screening decisions for older patients. Of note, Medicare generally covers cancer screenings without an upper age limit, except for lung cancer screening (ages 55-77 years).

Despite these recommendations, data from the National Health Interview Survey indicate unexpectedly high rates of screening in adults aged 85 years and older, many of whom have very limited life expectancies (Table 4). In 2015, more than one-third of women aged 85 years and older reported receiving a mammogram within the previous 2 years, and 18% reported receiving recent cervical cancer screening tests. More than one-half of adults aged 85 years and older reported receiving either a stool screening test within the past year or a sigmoidoscopy or colonoscopy within the past 5 to 10 years. Nearly 30% of men in this age group reported receiving a PSA test within the past year. Relatively high cancer screening rates in individuals with a limited life expectancy (9-year mortality risk ≥ 75%) have also been previously reported.

**Treatment**

Although age, per se, is not a contraindication for surgery, the oldest old patients with cancer are less likely to receive surgical treatment than those aged 65 to 84 years (Fig. 7). The most striking difference is observed for breast cancer; 89% of patients aged 65 to 84 years receive surgery compared with just 65% of those aged 85 years and older. Other studies have found that older patients with breast cancer are less likely to receive guideline-concordant care, even after accounting for patient comorbidities. Moreover, older patients with cancer are not only less likely to receive surgery, but often receive little or no treatment at all. This is partly because cancer-directed therapy is not appropriate for some older patients and because the benefit...
of prolonged survival does not outweigh potential adverse effects and impact on quality of life. In addition, death from causes other than cancer may be more likely for many older patients.\textsuperscript{76,77}

Treating patients aged 85 years and older who have cancer is complex because of the higher likelihood of comorbid conditions, declines in health status associated with aging, and the dearth of data regarding cancer treatment in this age group. Nearly one-half (47%) of patients aged 85 years and older have serious medical conditions that would require modification of standard cancer treatment.\textsuperscript{17} One study found that 39% of cancer patients older than 80 years were taking 5 or more medications, placing them at high risk for interactions with cancer drugs and other complications.\textsuperscript{78} In addition, age-associated physiologic changes, such as declines in liver and kidney function, can affect drug metabolism and influence therapeutic benefits and risks of toxicities and other adverse effects.\textsuperscript{79,80} Much remains unknown about the intersection of side effects from cancer therapies and age-associated conditions, such as cognitive impairment.\textsuperscript{81,82}

Importantly, age alone does not predict life expectancy, physical function, or the ability to tolerate treatment. A large body of research is currently focused on developing tools to enable clinicians to evaluate the functional age of patients as part of the treatment decision-making process. The Geriatric Assessment (GA) is a multidimensional, multidisciplinary tool that can be used to evaluate medical, psychosocial, cognitive, and functional capabilities in older adults. The GA can identify previously undetected health conditions and predict treatment toxicities and overall survival in patients with cancer.\textsuperscript{83}

### TABLE 4. Screening Prevalence Among Adults Aged 85 Years and Older, United States, 2015

| Test                                | Prevalence | 65-84 | 85+ |
|-------------------------------------|------------|-------|-----|
| Breast: Mammography within the past 2 y | 34%        |       |     |
| Cervix: Pap test within the past 3 y  | 18%        |       |     |
| Colon & rectum: Combined stool/endoscopy* | 52%        |       |     |
| Females                             | 47%        |       |     |
| Prostate: PSA test in the past 1 y\textsuperscript{1} | 29%        |       |     |

Abbreviations: Pap, Papanicolaou test; PSA, prostate-specific antigen test. Note: Estimates do not distinguish between examinations for screening and diagnosis.

\*Either a fecal occult blood test or a fecal immunochemical test within the past year, sigmoidoscopy within the past 5 years, or a colonoscopy within the past 10 years.

\*Among those with no reported prior diagnosis of prostate cancer.

![FIGURE 7. Receipt of Surgical Treatment for Selected Cancers in 2 Age Groups, United States, 2011 to 2015.](image-url)
Although the GA requires time and resource investments to implement, several recent studies support its feasibility and effectiveness, particularly in oncology clinics. A panel of geriatric oncology experts recommended the use of the GA in patients with cancer aged 75 years and older, and the American Society of Clinical Oncology recently recommended use of the GA in all patients aged 65 years and older under consideration for receipt of chemotherapy. Nevertheless, additional research is needed to determine the effectiveness and best practices for use of the GA in older patients who have cancer.

Finally, clinicians have inadequate evidence on which to base treatment decisions in older patients with cancer because of their extremely limited representation in clinical trials, largely due to enrollment restrictions. As a result, it is difficult to predict tolerance and response to new therapies, as well as their influence on other health conditions or common medications. The 2013 Institute of Medicine report, Delivering High-Quality Cancer Care: Charting a New Course for a System in Crisis, highlighted the critical need for improving the evidence base for treating older patients who have cancer.

Cancer Survival
Patients aged 85 years and older have the lowest relative survival of any age group. For the top 5 cancers in men and women aged 85 years and older and those aged 65 to 84 years are shown in Figure 8. In both age groups, relative survival approaches 100% for early-stage breast and prostate cancers and is 95% for in situ urinary bladder cancer. However, survival is 35% lower (in absolute terms) in adults aged 85 years and older compared with those aged 65 to 84 years for regional-stage prostate cancer and from 19% to 23% lower for those with local-stage lung and bladder cancers and regional-stage breast cancer. Poorer survival in the oldest old patients with cancer in part reflects the numerous challenges with cancer treatment in this population, as previously discussed. However, studies also suggest that older patients have benefited less than younger patients from recent advances in cancer therapeutics, whether because of lower efficacy or use of ineffective doses.

Survivorship
As of January 1, 2019, an estimated 1,944,280 adults aged 85 years and older were alive with a history of cancer, representing one-third of all men and one-fourth of all
women in this age group. Moreover, the oldest old are the fastest-growing group of cancer survivors, with nearly 4.7 million cancer survivors aged 85 years and older expected by 2040. Although research on the cancer survivor experience in the oldest old population is limited, some studies suggest a higher prevalence of side effects of cancer and its treatment, including depression, distress, and anxiety, that can further reduce physical functioning and physiological reserve, especially among those with multiple comorbidities. Nevertheless, a significant percentage of survivors in this age group remain resilient.

Physical activity, maintaining a healthy weight, and subjective happiness serve as protective factors against functional decline among older survivors. Recommendations for physical activity in the oldest old should be individualized to optimize participation, safety, and efficiency. Older cancer survivors can also benefit from programs that encourage smoking cessation, weight management, and social support. Survivorship care plans for older cancer survivors should be tailored to meet their unique needs.

Conclusions
This report provides comprehensive information on cancer occurrence in adults aged 85 years and older, the fastest growing age group in the United States. Although we found that cancer trends in the oldest old are generally similar to those in the younger (ages 65-84 years) age group examined, we noted some important differences (eg, lung cancer and melanoma), reflecting strong birth cohort effects because of elevated risks in the oldest generations. We also documented unexpectedly high rates of screening in adults aged 85 years and older, many of whom have very limited life expectancies. Furthermore, the undertreatment of otherwise fit older adults and the overtreatment of vulnerable individuals are both significant challenges. The rapid growth and diversification of the population aged 85 years and older will increase demand and complexities for cancer care and could have a substantial impact on medical care resource allocation. There is an urgent need to develop a more comprehensive evidence base to guide treatment decisions for these understudied patients with cancer through increased enrollment in clinical trials and to leverage research designs and infrastructure for generating evidence on older adults with cancer.

References
1. US Census Bureau. 2017 National Population Projections Tables. Main Series. Table 2: Projected age and sex composition of the population: 2017-2060. Washington, DC: US Census Bureau, Population Division; 2018.
2. Preston SH, Vierboom YC, Stokes A. The role of ethnicity in exceptionally slow US mortality improvement. Proc Natl Acad Sci U S A. 2018;115:957-961.
3. Crimmins EM, Preston SH, Cohen B, eds. Explaining Divergent Levels of Longevity in High-Income Countries. National Research Council Panel on Understanding Divergent Trends in Longevity in High-Income Countries. Washington DC: National Academies Press; 2011.
4. Kontis V, Bennett JE, Mathers CD, Li G, Foreman K, Ezzati M. Future life expectancy in 35 industrialised countries: projections with a Bayesian model ensemble. Lancet. 2017;389:1323-1335.
5. Thun MJ, Carter BD, Feskanich D, et al. 50-year trends in smoking-related mortality in the United States. N Engl J Med. 2013;368:351-364.
6. Colby SL, Ortmann JM. Projections of the Size and Composition of the US Population: 2014 to 2060. Population Estimates and Projections. Current Population Reports. P25-1143. Washington, DC: US Census Bureau; 2015.
7. US Census Bureau. Race and Hispanic origin by selected age groups. Projections for the United States: 2017-2060. Main Series. Table 6. Washington, DC: US Census Bureau, Population Division; 2018.
8. Bernard MA, Clayton JA, Lauer MS. Inclusion across the lifespan: NIH policy for clinical research. JAMA. 2018;320:1535-1536.
9. Hurria A, Levitt LA, Dale W, et al. Improving the evidence base for treating older adults with cancer: American Society of Clinical Oncology statement. J Clin Oncol. 2015;33:3826-3833.
10. Williams GR, Mackenzie A, Magnuson A, et al. Comorbidity in older adults with cancer. J Geriatr Oncol. 2016;7:249-257.
11. Surveillance, Epidemiology, and End Results (SEER) Program. SEER*Stat Database: North American Association of Central Cancer Registries (NAACCR) Incidence Data-Cancer in North America (CiNA) Analytic File, 1995-2015, for NHIAv2 Origin, Custom File With County, ACS Facts and Figures Projection Project (Which Includes Data From the Centers for Disease Prevention and Prevention's [CDC]'s] National Program of Cancer Registries [NPCR], the Canadian Council of Cancer Registry’s [CCCR]'s Provincial and Territorial Registries, and the National Cancer Institute’s [NCI]'s SEER Registries). Springfield, IL: North American Association of Central Cancer Registries; 2018.
12. Surveillance, Epidemiology, and End Results (SEER) Program. SEER*Stat Database: Incidence-SEER 9 Regs Research Data with Delay-Adjustment, Malignant Only, Nov. 2017 Sub (1975-2015) [Katrina/Rita Population Adjustment]--Linked to County Attributes-Total US, 1969-2015 Counties. Bethesda, MD: National Cancer Institute, Division of Cancer Control and Population Sciences, Surveillance Research Program, Surveillance Systems Branch; 2018.
13. Surveillance, Epidemiology, and End Results (SEER) Program. SEER*Stat Database: North American Association of Central Cancer Registries (NAACCR) Incidence Data-Cancer in North America (CiNA) Analytic File, 1995-2015, for NHIAv2 Origin, Custom File With County, ACS Facts and Figures Projection Project (Which Includes Data From the Centers for Disease Prevention and Prevention’s [CDC]'s] National Program of Cancer Registries [NPCR], the Canadian Council of Cancer Registry’s [CCCR]'s Provincial and Territorial Registries, and the National Cancer Institute’s [NCI]'s SEER Registries). Springfield, IL: North American Association of Central Cancer Registries; 2018.
14. Surveillance, Epidemiology, and End Results (SEER) Program. SEER*Stat Database: North American Association of Central Cancer Registries (NAACCR) Incidence Data-Cancer in North America (CiNA) Analytic File, 1995-2015, for NHIAv2 Origin, Custom File With County, ACS Facts and Figures Projection Project (Which Includes Data From the Centers for Disease Prevention and Prevention’s [CDC]'s] National Program of Cancer Registries [NPCR], the Canadian Council of Cancer Registry’s [CCCR]'s Provincial and Territorial Registries, and the National Cancer Institute’s [NCI]'s SEER Registries). Springfield, IL: North American Association of Central Cancer Registries; 2018.
Population Adjustment: Underlying mortality data provided by National Center for Health Statistics (cdc.gov/nchs). Bethesda, MD: National Cancer Institute, Division of Cancer Control and Population Sciences, Surveillance Research Program, Surveillance Systems Branch; 2018.

16. National Center for Health Statistics. National Health Interview Survey. 2015. Public use data file and documentation. Hyattsville, MD: National Center for Health Statistics; 2016. cdc.gov/nchs/nhis/nhis_2015_data_releas.htm. Accessed November 12, 2018.

17. Bluethmann SM, Mariotto AB, Rowland JH. Anticipating the “Silver Tsunami”: prevalence trajectories and comorbidity burden among older cancer survivors in the United States. Cancer Epidemiol Biomarkers Prev. 2016;25:1029-1036.

18. Siegel RL, Miller KD, Jemal A. Cancer statistics, 2019. CA Cancer J Clin. 2019;69:7-34.

19. Surveillance, Epidemiology, and End Results (SEER) Program. SEER*Stat Database: Incidence-SEER 18 Regs Research Data with Delay-Adjustment, Malignant Only, Nov. 2017 Sub (2000-2015) <Katrina/Rita Population Adjustment->. Linked To County Attributes-Total US, 1969-2016 Counties. Bethesda, MD: National Cancer Institute, Division of Cancer Control and Population Sciences, Surveillance Research Program, Surveillance Systems Branch; 2018.

20. Fritz A, Percy C, Jack A, et al, eds. International Classification of Diseases for Oncology. 3rd ed. Geneva, Switzerland: World Health Organization; 2000.

21. World Health Organization. International Statistical Classification of Diseases and Related Health Problems. 10th Revision. Volumes 1-III. Geneva, Switzerland: World Health Organization; 2011.

22. Statistical Research and Applications Branch, National Cancer Institute. DevCan: Probability of Developing or Dying of Cancer Software. Version 6.7.6. Bethesda, MD: Statistical Research and Applications Branch, National Cancer Institute; 2018.

23. Surveillance Research Program, National Cancer Institute. SEER*Stat Software. Version 8.3.5. Bethesda, MD: National Cancer Institute; 2018.

24. Statistical Research and Applications Branch, National Cancer Institute. Jointpoint Regression Program. Version 4.6.0.0. Bethesda, MD: Statistical Research and Applications Branch, National Cancer Institute; 2018.

25. Palmer S, Albergante L, Blackburn CC, Newman TJ. Thymic involution and rising disease incidence with age. Proc Natl Acad Sci U S A. 2018;115:1883-1888.

26. White MC, Holman DM, Boehm JE, Peipins LA, Grossman M, Henley SJ. Age and cancer risk: a potentially modifiable relationship. Am J Prev Med. 2014;46(3 suppl 1):S7-S15.

27. Falandry C, Bonnafoy M, Freyer G, Gilson ED. Biology of cancer and aging: a complex association with cellular senescence. J Clin Oncol. 2014;32:2604-2610.

28. Hanson HA, Smith KR, Stroup AM, Harrell CD. An age-period-cohort analysis of cancer incidence among the oldest old, Utah 1973-2002. Popul Stud. 2015;69:7-22.

29. Harding C, Pompei F, Wilson R. Peak and decline in cancer incidence, mortality, and prevalence at old ages. Cancer. 2012;118:1371-1386.

30. Joseph SC, Delcastilo E, Loukas M, Osiro SD. Common cancers in centenarians. Med Sci Monit. 2014;20:18-23.

31. Macieira-Coelho A. Cancers and the concept of cell senescence. Biogerontology. 2010;11:211-227.

32. Pompei F, Polkanov M, Wilson R. Age distribution of cancer in mice: the incidence turnover at old age. Toxicol Ind Health. 2001;17:7-16.

33. Campisi J. Aging, cellular senescence, and cancer. Annu Rev Physiol. 2013;75:685-705.

34. Bonafe M, Barbi C, Storci G, et al. What studies on human longevity tell us about the risk for cancer in the oldest old: data and hypotheses on the genetics and immunology of centenarians. Exp Gerontol. 2002;37:1263-1271.

35. Pavlidis N, Stanta G, Audisio RA. Cancer prevalence and mortality in centenarians: a systematic review. Crit Rev Oncol Hematol. 2012;83:145-152.

36. Miller B, Feuer E, Altekruse SD. Cancer incidence patterns in the oldest ages using expanded age categories from SEER registry data and the 2010 Census population. J Registr Mgmt. 2017;44:130-135.

37. Thakkar JP, McCarthy BJ, Villano JD. Age-specific cancer incidence rates increase through the oldest age groups. Am J Med Sci. 2014;348:65-70.

38. Krok-Schoen JL, Adams IK, Baltic RD, Fisher JL. Ethnic disparities in cancer incidence and survival among the oldest old in the United States. Ethn Health. 2017;2017:1-14.

39. Krok-Schoen JL, Fisher JL, Baltic RD, Paskett ED. White-black differences in cancer incidence, stage at diagnosis, and survival among adults aged 85 years and older in the United States. Cancer Epidemiol Biomarkers Prev. 2016;25:1517-1523.

40. Siegel RL, Jemal A, Wender RC, Gansler T, Ma J, Brawley OW. An assessment of progress in cancer control. CA Cancer J Clin. 2018;68:329-339.

41. O’Keefe EB, Meltzer JP, Betha TN. Health disparities and cancer: racial disparities in cancer mortality in the United States, 2000-2010. Front Public Health. 2015;3:51.

42. Morris AM, Rhoads KF, Stain SC, Birkmeyer JD. Understanding racial disparities in cancer treatment and outcomes. J Am Coll Surg. 2010;211:105-113.

43. Shih YT, Xu Y, Liu L, Smialkowski FD. Rising prices of targeted oral anticancer medications and associated financial burden on Medicare beneficiaries. J Clin Oncol. 2017;35:2482-2489.

44. Holford TR, Levy DT, McKay LA, et al. Patterns of birth cohort–specific smoking histories, 1965-2009. Am J Prev Med. 2014;46:e31-e37.

45. Autier P, Koechlin A, Boni M. The forthcoming inexorable decline of cutaneous melanoma mortality in light-skinned populations. Eur J Cancer. 2015;51:869-878.

46. Erdmann F, Lortet-Tieulent J, Schuz J, et al. International trends in the incidence of malignant melanoma 1953-2008—are recent generations at higher or lower risk? Int J Cancer. 2013;132:385-400.

47. Gundrun JD, Go RS. Cancer in the oldest old in the United States: current statistics and projections. J Geriatr Oncol. 2012;3:299-306.

48. Feuer EJ, Merrill RM, Hankey BF. Cancer surveillance series: interpreting trends in prostate cancer—part II: cause of death misclassification and the recent rise and fall in prostate cancer mortality. J Natl Cancer Inst. 1999;91:1025-1032.

49. Etzioni R, Tsodikov A, Mariotto A, et al. Quantifying the role of PSA screening in the US prostate cancer mortality decline. Cancer Causes Control. 2008;19:175-181.

50. Tsodikov A, Gulati R, Heinsjówki EAM, et al. Reconciling the effects of screening on prostate cancer mortality in the ERSPC and PLCO trials. Ann Intern Med. 2017;167:449-455.
51. Negoića S, Feuer EJ, Mariotto A, et al. Annual Report to the Nation on the Status of Cancer, part II: recent changes in prostate cancer trends and disease characteristics. *Cancer*. 2018;124:2801-2814.

52. Lee KT, Harris RP, Schoenborn NL. Individualized approach to cancer screening in older adults. *Clin Geriatr Med*. 2018;34:11-23.

53. Braithwaite D, Demb J, Henderson LM. Optimal breast cancer screening strategies for older women: current perspectives. *Clin Interv Aging*. 2016;11:111-125.

54. Schonberg MA, Marcantonio ER, Li D, Silliman RA, Ngo L, McCarthy EP. Breast cancer among the oldest old: tumor characteristics, treatment choices, and survival. *J Clin Oncol*. 2010;28:2039-2045.

55. Warren JL, Klabunde CN, Mariotto AB, et al. Cancer screening among older US adults: results from a national survey. *JAMA Oncol*. 2018;4:1126-1128.

56. Lee SJ, Boscardin WJ, Stijacic-Cenzer I, Conell-Price J, O’Brien S, Walter LC. Time lag to benefit after screening for breast and colorectal cancer: meta-analysis of survival data from the United States, Sweden, United Kingdom, and Denmark. *BMJ*. 2013;346:e8441.

57. Rodin MB. Should you screen nursing home residents for cancer? *J Geriatr Oncol*. 2017;8:154-159.

58. Yourman LC, Lee SJ, Schonberg MA, Widera EW, Smith AK. Prognostic indices for older adults: a systematic review. *JAMA*. 2012;307:182-189.

59. Mohile SG, Dale W, Henderson LM. Time lag to benefit after screening for breast and colorectal cancer: meta-analysis of survival data from the United States, Sweden, United Kingdom, and Denmark. *BMJ*. 2013;346:e8441.

60. Lee SJ, Smith AK. Prognostic indices for older adults: a systematic review and framework for future research. *J Gen Intern Med*. 2013;28:292-298.

61. Siu AL. US Preventive Services Task Force. Screening for breast cancer: US Preventive Services Task Force recommendation statement. *Ann Intern Med*. 2016;164:279-296.

62. Wolf AMD, Fontham ETH, Church TR, et al. Colorectal cancer screening for average-risk adults: 2018 guideline update from the American Cancer Society. CA Cancer J Clin. 2018;68:250-281.

63. US Preventive Services Task Force, Bibbins-Domingo K, Grossman DC, et al. Screening for colorectal cancer: US Preventive Services Task Force recommendation statement. *JAMA*. 2016;315:2564-2575.

64. US Preventive Services Task Force, Grossman DC, Curry SJ, et al. Screening for prostate cancer: US Preventive Services Task Force recommendation statement. *JAMA*. 2018;319:1901-1913.

65. US Preventive Services Task Force, Curry SJ, Krist AH, et al. Screening for cervical cancer: US Preventive Services Task Force recommendation statement. *JAMA*. 2018;320:674-686.

66. Moyer VA; US Preventive Services Task Force. Screening for lung cancer: US Preventive Services Task Force recommendation statement. *Ann Intern Med*. 2014;160:330-338.

67. American Geriatrics Society. Ten Things Clinicians and Patients Should Question. New York, NY: American Geriatrics Society; 2015. choosingwisely.org/societies/american-geriatrics-society/. Accessed September 25, 2018.

68. Royce TJ, Hendrix LH, Stokes WA, Allen IM, Chen RC. Cancer screening rates in individuals with different life expectancies. *JAMA*. 2014;160:330-338.

69. LeMasters T, Madhavan SS, Sambamoorthi U, Hazard-Jenkins HW, Kelly KM, Long D. Receipt of guideline-concordant care among older women with stage I-II breast cancer: a population-based study. *J Natl Compr Canc Netw*. 2018;16:703-710.

70. Giordano SH, Hortobagyi GN, Kau SW, Theriault RL, Bondy ML. Breast cancer treatment guidelines in older women. *J Clin Oncol*. 2005;23:783-791.

71. Fang P, He W, Gomez DR, et al. Influence of age on guideline-concordant care for elderly patients in the United States. *Int J Radiat Oncol Biol Phys*. 2017;98:748-757.

72. Edwards BK, Noone AM, Mariotto AB, et al. Annual Report to the Nation on the Status of Cancer, 1975-2010, featuring prevalence of comorbidity and impact on survival among persons with lung, colorectal, breast, or prostate cancer. *Cancer*. 2014;120:1290-1314.

73. Jorgensen TL, Hallas J, Friis S, Herrstedt JD. Comorbidity in elderly cancer patients in relation to overall and cancer-specific mortality. *Br J Cancer*. 2012;106:1353-1360.

74. Hersh LR, Beldowski K, Hajjar ED. Polypharmacy in the geriatric oncology population. *Curr Oncol Rep*. 2017;19:73.

75. Nightingale G, Schwartz R, Kachur E, et al. Clinical pharmacology of oncology agents in older adults: a comprehensive review of how chronic and functional age can influence treatment-related effects. *J Geriatr Oncol*. 2019;10:4-30.

76. Jaul E, Barron J. Age-related diseases and clinical and public health implications for the 85 years old and over population. *Front Public Health*. 2017;5:335.

77. Mandelblatt JS, Hurria A, McDonald BC, et al. Cognitive effects of cancer and its treatments at the intersection of aging: what do we know; what do we need to know? *Semin Oncol*. 2013;40:709-725.

78. Loh KP, Jansins MC, Mohile SG, et al. Chemotherapy-related cognitive impairment in older patients with cancer. *J Geriatr Oncol*. 2016;7:270-280.

79. Kenis C, Baitar A, Decoster L, et al. The added value of geriatric screening and assessment for predicting overall survival in older patients with cancer. *Cancer*. 2018;124:3753-3763.

80. Jackson G, Gabe R, Johnson M, et al. Using a geriatric oncology assessment framework for predicting overall survival in older patients with cancer. *Cancer*. 2018;124:3753-3763.

81. Jackson G, Gabe R, Johnson M, et al. Using a geriatric oncology assessment framework for predicting overall survival in older patients with cancer. *Cancer*. 2018;124:3753-3763.

82. Loh KP, Jansins MC, Mohile SG, et al. Chemotherapy-related cognitive impairment in older patients with cancer. *J Geriatr Oncol*. 2016;7:270-280.

83. Kenis C, Baitar A, Decoster L, et al. The added value of geriatric screening and assessment for predicting overall survival in older patients with cancer. *Cancer*. 2018;124:3753-3763.

84. Jackson G, Gabe R, Johnson M, et al. Using a geriatric oncology assessment framework for predicting overall survival in older patients with cancer. *Cancer*. 2018;124:3753-3763.
87. Mohile SG, Velarde C, Hurria A, et al. Geriatric assessment-guided care processes for older adults: a Delphi consensus of geriatric oncology experts. *J Natl Compr Canc Netw.* 2015;13:1120-1130.

88. Wildiers H, Heeren P, Puts M, et al. International Society of Geriatric Oncology consensus on geriatric assessment in older patients with cancer. *J Clin Oncol.* 2014;32:2595-2603.

89. Freedman RA, Ruddy KJ. Who are the patients in our clinical trials for cancer? *J Clin Oncol.* 2019;37:1518-1523.

90. Institute of Medicine. Delivering High Quality Cancer Care: Charting a New Course for a System in Crisis. Washington, DC: National Academies Press; 2013.

91. Hurria A, Naylor M, Cohen HJ. Improving the quality of cancer care in an aging population: recommendations from an IOM report. *JAMA.* 2013;310:1795-1796.

92. Freedman RA, Foster JC, Seisler DK, et al. Accrual of older patients with breast cancer to Alliance systemic therapy trials over time: protocol A151527. *J Clin Oncol.* 2017;35:421-431.

93. Noone AM, Howlader N, Krapcho M, et al, eds. SEER Cancer Statistics Review, 1975-2015. Bethesda, MD: National Cancer Institute; 2018.

94. Mukhtar F, Boffetta P, Dabo B, et al. Disparities by race, age, and sex in the improvement of survival for lymphoma: findings from a population-based study. *PLoS One.* 2018;13:e0199745.

95. Zeng C, Wen W, Morgans AK, Pao W, Shu XO, Zheng WD. Disparities by race, age, and sex in the improvement of survival for major cancers: results from the National Cancer Institute Surveillance, Epidemiology, and End Results (SEER) program in the United States, 1990 to 2010. *JAMA Oncol.* 2015;1:88-96.

96. Cohen M. Depression, anxiety, and somatic symptoms in older cancer patients: a comparison across age groups. *Psychooncology.* 2014;23:151-157.

97. Goldzweig G, Baider L, Rottenberg Y, Andritsch E, Jacobs JM. Is age a risk factor for depression among the oldest old with cancer? *J Geriatr Oncol.* 2018;9:476-481.

98. Weaver KE, Leach CR, Leng X, et al. Physical functioning among women 80 years of age and older with and without a cancer history. *J Gerontol A Biol Sci Med Sci.* 2016;71(suppl 1):S23-S30.

99. Demark-Wahnefried W, Morey MC, Sloane R, et al. Reach out to enhance wellness home-based diet-exercise intervention promotes reproducible and sustainable long-term improvements in health behaviors, body weight, and physical functioning in older, overweight/obese cancer survivors. *J Clin Oncol.* 2012;30:2354-2361.

100. Morey MC, Snyder DC, Sloane R, et al. Effects of home-based diet and exercise on functional outcomes among older, overweight long-term cancer survivors: RENEW: a randomized controlled trial. *JAMA.* 2009;301:1883-1891.

101. Bluethmann SM, Sciamanna CN, Winkels RM, Sturgeon KM, Schmitz KH. Healthy living after cancer treatment: considerations for clinical and community practice. *Am J Lifestyle Med.* 2018;12:215-219.

102. Guerard EJ, Nightingale G, Bellizzi K, et al. Survivorship care for older adults with cancer: U13 conference report. *J Geriatr Oncol.* 2016;7:305-312.