Cancer Treatment and Survivorship Statistics, 2019

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Abstract: The number of cancer survivors continues to increase in the United States because of the growth and aging of the population as well as advances in early detection and treatment. To assist the public health community in better serving these individuals, the American Cancer Society and the National Cancer Institute collaborate every 3 years to estimate cancer prevalence in the United States using incidence and survival data from the Surveillance, Epidemiology, and End Results cancer registries; vital statistics from the Centers for Disease Control and Prevention’s National Center for Health Statistics; and population projections from the US Census Bureau. Current treatment patterns based on information in the National Cancer Data Base are presented for the most prevalent cancer types. Cancer-related and treatment-related short-term, long-term, and late health effects are also briefly described. More than 16.9 million Americans (8.1 million males and 8.8 million females) with a history of cancer were alive on January 1, 2019; this number is projected to reach more than 22.1 million by January 1, 2030 based on the growth and aging of the population alone. The 3 most prevalent cancers in 2019 are prostate (3,650,030), colon and rectum (776,120), and melanoma of the skin (684,470) among males, and breast (3,861,520), uterine corpus (807,860), and colon and rectum (768,650) among females. More than one-half (56%) of survivors were diagnosed within the past 10 years, and almost two-thirds (64%) are aged 65 years or older. People with a history of cancer have unique medical and psychosocial needs that require proactive assessment and management by follow-up care providers. Although there are growing numbers of tools that can assist patients, caregivers, and clinicians in navigating the various phases of cancer survivorship, further evidence-based resources are needed to optimize care.

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Introduction

The number of cancer survivors continues to grow in the United States despite overall declining age-standardized incidence rates in men and stable rates in women.1 This reflects an increasing number of new cancer diagnoses resulting from a growing and aging population as well as increases in cancer survival because of advances in early detection and treatment. Many cancer survivors must cope with the physical effects of cancer and its treatment, potentially leading to functional and cognitive impairments as well as other psychological and economic sequelae.2 To help the public health community better serve this unique population, the American Cancer Society collaborates triennially with the National Cancer Institute to estimate contemporary and future complete cancer prevalence in the United States for the most common cancers. Statistics on contemporary treatment patterns and survival, as well as information about issues related to survivorship, are also presented. Herein, “cancer survivor” refers to any person who has been diagnosed with cancer, from the time of diagnosis through the remainder of life, although it is important to recognize that not all people with a history of cancer identify as survivors.3
**Materials and Methods**

**Prevalence Estimates**

Cancer survivor prevalence as of January 1, 2019, was estimated using the Prevalence Incidence Approach Model, which calculates prevalence from cancer incidence and survival and all-cause mortality. Incidence and survival were modeled by cancer type, sex, and age group using invasive cases (except urinary bladder, which included in situ cases) diagnosed from 1975 through 2015 from the 9 oldest registries in the population-based Surveillance, Epidemiology, and End Results (SEER) program (2017 submission data). As it is possible for an individual to be diagnosed with more than one cancer, for specific cancer site estimates, incident cases included the first primary for the specific cancer site between 1975 and 2015, whereas total cancer prevalence was calculated using the first primary diagnosed in that period. Estimates do not distinguish between individuals currently undergoing initial treatment, those with clinical evidence of residual or recurrent disease, or those who are living cancer free.

Mortality data for 1975 through 2015 were obtained from the National Center for Health Statistics. Population projections from 2016 through 2030 were obtained from the US Census Bureau. Projected US incidence and mortality for 2016 to 2030 were calculated by applying 5-year average rates for 2011 through 2015 to the respective US population projections by age, sex, race, and year. Survival, incidence, and all-cause mortality rates were assumed to be constant from 2016 through 2030.

**2019 Case Estimates**

The method for estimating the number of new US cancer cases in 2019 is described in detail elsewhere. Briefly, the total number of cases in each state is estimated using a spatiotemporal model based on incidence data from 49 states and the District of Columbia for the years 2001 through 2015 that met the North American Association of Central Cancer Registries’ high-quality data standard for incidence. Then, the number of new cases nationally and in each state is temporally projected 4 years ahead using vector autoregression. This method considers geographic variations in sociodemographic and lifestyle factors, medical settings, and cancer screening behaviors as predictors of incidence and also accounts for expected delays in case reporting.

**Stage at Diagnosis**

Several different staging systems are used to classify cancers. The American Joint Committee on Cancer (AJCC) staging system is the most common in clinical settings and is used herein for the description of stage-specific distribution and treatment patterns with the exception of prostate cancer, for which SEER Summary Stage is used because of missing AJCC staging information for a large proportion of cases.

**Survival**

Survival information is presented in terms of relative survival, which adjusts for normal life expectancy by comparing survival among patients with cancer versus that of the general population, controlling for age, race, sex, and year. The SEER 18 registries were the source for contemporary 5-year survival (diagnosis years 2008-2014), whereas long-term changes in 5-year survival are based on data from the 9 oldest SEER registries. Many of these statistics were originally published in the *SEER Cancer Statistics Review, 1975 to 2015*. All additional survival analyses were conducted using the National Cancer Institute's SEER*Stat software (version 8.3.5).

**Treatment**

Initial treatment data obtained from the National Cancer Data Base (NCDB) are presented for cases diagnosed in 2016 for all selected cancers except non-Hodgkin lymphoma (NHL) and testicular cancer, for which aggregated 2012 to 2016 data were used because of the relatively small number of cases. The NCDB is a hospital-based cancer registry jointly sponsored by the American Cancer Society and the American College of Surgeons and includes greater than 70% of all invasive cancers in the United States from more than 1500 facilities accredited by the American College of Surgeons’ Commission on Cancer (CoC). When appropriate, a literature review was performed to supplement NCDB treatment information presented herein, particularly for trends or cancers often diagnosed in the outpatient setting, such as prostate cancer or leukemia.

The cancer treatment modalities reported are surgery, radiation therapy, and systemic treatment, including chemotherapy, targeted therapy, hormonal therapy, and immunotherapy. Many common targeted therapies are classified as chemotherapy in the NCDB. For consistency and comparability, chemotherapy in this report includes targeted therapy and immunotherapies, except for diffuse large B-cell lymphoma (DLBCL), non–small cell lung cancer (NSCLC), and urinary bladder cancers, for which immunotherapy has been examined separately. For more information regarding the drug classification system used for the NCDB and other cancer registries, see the SEER-Rx website (seer.cancer.gov/tools/seerrx). Methods of drug delivery are not available in the NCDB and therefore, topical or intravesical chemotherapy cannot be distinguished from systemic chemotherapy. Treatment patterns...
do not include diagnostic procedures such as biopsies but do include procedures that may be simultaneously used for treatment and diagnosis, such as transurethral resection of a urinary bladder tumor (TURBT). For more information on the NCDB, please visit their website (facs.org/cancer/ncdb).

Selected Findings
Cancer Prevalence

More than 16.9 million Americans with a history of cancer were alive on January 1, 2019, and this number is projected to grow to more than 22.1 million by January 1, 2030. These estimates do not include carcinoma in situ (CIS) of any site (except urinary bladder) or basal cell and squamous cell skin cancers. The 3 most prevalent cancers in 2019 are prostate (3,650,030), colon and rectum (776,120), and melanoma (684,470) among males, and breast (3,861,520), uterine corpus (807,860), and colon and rectum (768,650) among females (Fig. 1). The distribution of prevalent cancers differs from that for incident cancers because prevalent cancers reflect survival and median age at diagnosis as well as cancer occurrence.

The majority of cancer survivors (68%) were diagnosed 5 or more years ago, and 18% were diagnosed 20 or more years ago (Table 1). Nearly two-thirds (64%) are aged 65 years or older, although age distribution varies by cancer type (Table 2). For example, the majority of prostate cancer survivors (82%) are aged 65 years or older compared with only one-half (54%) of melanoma survivors (Fig. 2).

FIGURE 1. Estimated Number of US Cancer Survivors by Site. Estimates do not include in situ carcinoma of any site except urinary bladder and do not include basal cell or squamous cell skin cancers.

Selected Cancers
Breast (female)

It is estimated that there are more than 3.8 million women living in the United States with a history of invasive breast cancer, and 268,600 women will be newly diagnosed in 2019. More than 150,000 breast cancer survivors are living with metastatic disease, three-quarters of whom were originally diagnosed with stage I through III cancer.11 Approximately 64% of breast cancer survivors (more than 2.4 million women) are aged 65 years and older, whereas 7% are aged younger than 50 years (Fig. 2). The age distribution of breast cancer survivors is younger than that for the other most common incident cancers in the United States (lung, colorectum, and prostate), in part because the median age at diagnosis is younger (61 years).7

Treatment and survival
The most common treatment among women with early-stage (stage I or II) breast cancer is breast-conserving surgery (BCS) with adjuvant radiation therapy (49%), although 34% of patients undergo mastectomy (Fig. 3). By comparison, more than two-thirds (68%) of patients with stage III disease undergo mastectomy, most of whom also receive adjuvant chemotherapy. Women diagnosed with metastatic disease (stage IV) most often receive radiation and/or chemotherapy alone (56%), with one-quarter receiving no treatment (although some of these patients receive hormonal therapy).9 Among patients with hormone receptor–positive tumors, 81% receive hormonal therapy, although the percentage is slightly lower for those with metastatic disease (71%).9
When BCS followed by radiation to the breast is appropriately used for localized or regional cancers, long-term survival is the same as that with mastectomy.\textsuperscript{12,13} However, some patients require mastectomy because of tumor characteristics (eg, locally advanced stage, large or multiple tumors), because adjuvant radiation is contraindicated (eg, previously received radiation, pre-existing medical conditions such as active connective tissue disease), or because of other obstacles. BCS–eligible women are increasingly electing mastectomy for a variety of reasons, including reluctance to undergo radiation therapy and fear of recurrence.\textsuperscript{14} Younger women (aged <40 years) and patients with larger and/or more aggressive tumors are more likely to be treated with mastectomy\textsuperscript{14,15} and are particularly more likely to also undergo a contralateral prophylactic mastectomy (CPM).\textsuperscript{16} The proportion of women undergoing surgery for nonmetastatic disease in one breast who receive CPM has increased rapidly, from 10% in 2004 to 33% in 2012 among women aged 20 to 44 years and from 4% to 10% during the same time period among those aged 45 years and older.\textsuperscript{16} CPM receipt is highest in the Midwest and lowest in the Northeast and West, which may reflect differences in physician beliefs and practices as well as patient-related factors. In parallel with the rise in CPM, a recent large study found that the 41% of women who underwent any mastectomy (unilateral or bilateral) received immediate breast-reconstructive procedures, up from 18% in 2004.\textsuperscript{17} Women who are younger,

### Table 1. Estimated Number of US Cancer Survivors by Sex and Years Since Diagnosis as of January 1, 2019

| YEARS SINCE DIAGNOSIS | MALE AND FEMALE | MALE | FEMALE |
|-----------------------|-----------------|------|--------|
|                       | NO. PERCENT CUMULATIVE PERCENT | NO. PERCENT CUMULATIVE PERCENT | NO. PERCENT CUMULATIVE PERCENT |
| 0 to <5               | 5,527,420 33% 33% | 2,921,800 36% 36% | 2,605,620 30% 30% |
| 5 to <10              | 3,802,050 23% 55% | 1,957,220 24% 60% | 1,844,830 21% 51% |
| 10 to <15             | 2,684,620 16% 71% | 1,323,430 16% 76% | 1,361,190 16% 66% |
| 15 to <20             | 1,855,780 11% 82% | 843,970 10% 87% | 1,011,810 12% 78% |
| 20 to <25             | 1,198,320 7% 89% | 491,980 6% 93% | 706,340 8% 86% |
| 25 to <30             | 773,770 5% 94% | 290,450 4% 96% | 483,320 6% 91% |
| >30                   | 1,078,430 6% 100% | 309,960 4% 100% | 768,470 9% 100% |

Note: Percentages do not sum to 100% due to rounding.
Source: Surveillance Research Program, Division of Cancer Control and Population Sciences, National Cancer Institute.

### Table 2. Estimated Number of US Cancer Survivors by Sex and Age at Prevalence as of January 1, 2019

| AGE, YEARS | MALE AND FEMALE | MALE | FEMALE |
|------------|-----------------|------|--------|
| All ages   | 16,920,370 8,138,790 8,781,580 | 33% 33% | 2,921,800 2,605,620 30% 30% |
| Birth-14   | 65,850 32,300 33,550 | <1% 1% | <1% 1% |
| 15-19      | 47,760 23,780 23,980 | <1% 1% | <1% 1% |
| 20-29      | 194,360 93,540 100,820 | 1% 2% | 1% 2% |
| 30-39      | 436,300 177,810 258,490 | 3% 4% | 3% 5% |
| 40-49      | 969,450 351,970 617,490 | 6% 8% | 6% 12% |
| 50-59      | 2,380,560 964,510 1,416,050 | 14% 24% | 16% 28% |
| 60-69      | 4,466,900 2,185,200 2,281,700 | 26% 51% | 26% 54% |
| 70-79      | 4,760,980 2,562,940 2,198,040 | 28% 79% | 25% 79% |
| ≥80        | 3,598,220 1,746,740 1,851,480 | 21% 100% | 21% 100% |
| Birth-19   | 113,610 56,090 57,520 | <1% 1% | <1% 1% |
| 20-64      | 6,012,430 2,535,730 3,476,700 | 36% 36% | 40% 40% |
| ≥65        | 10,794,330 5,546,970 5,247,360 | 64% 68% | 60% 100% |

Note: Percentages do not sum to 100% due to rounding.
Source: Surveillance Research Program, Division of Cancer Control and Population Sciences, National Cancer Institute.
white, privately insured, or more highly educated, as well as those who undergo CPM, are more likely to undergo reconstruction.\(^{18-20}\)

Biological factors that influence breast cancer survival include stage, tumor grade, estrogen and progesterone hormone receptor status, and human epidermal growth factor receptor 2 (HER2) status. The 5-year relative survival rate has increased from 79% for patients diagnosed during 1984 through 1986 to 91% for those diagnosed during 2008 through 2014,\(^7\) largely because of improvements in treatment, especially for hormone receptor-positive and HER2-positive tumors (eg, aromatase inhibitors and trastuzumab, respectively), and earlier stage of disease at diagnosis with the increased prevalence of mammography screening.\(^{21}\) However, treatment advances for triple-negative tumors (estrogen and progesterone hormone receptor–negative and HER2-negative tumors) have lagged behind those for other molecular subtypes and thus far have been largely limited to chemotherapy. Recently, a combination of an immunotherapy drug with chemotherapy was approved for metastatic triple-negative breast cancer.\(^{22}\) Although several immunotherapy and targeted therapy treatments are currently under investigation,\(^{23}\) these treatments may only be effective for a subset of patients because triple-negative cancers encompass a heterogeneous range of molecular profiles.

The 5-year relative survival approaches 100% for the 44% of patients with breast cancer who are diagnosed at
stage I (Fig. 4), but declines to 26% for those diagnosed with stage IV breast cancer (5% of cases). Black women are less likely than white women to be diagnosed with stage I breast cancer (34% vs 46% of cases) and have lower survival for every stage.7 In one study, insurance status accounted for more than one-third of the black-white disparity in breast cancer survival among nonelderly patients after adjusting for treatment differences and other clinical factors.24 Socioeconomic factors, comorbidities, and biological differences in cancers (eg, higher incidence of triple-negative cancers among black women) also contribute to the survival disparity.24,25

Short-term and long-term health effects

Lymphedema of the arm occurs in 19.9% of women who undergo axillary lymph node dissection and in 5.6% of women who have a sentinel lymph node biopsy.26 Irradiation of the regional lymph nodes may also increase risk, particularly among patients also receiving axillary lymph node dissection.27 Early diagnosis of lymphedema is important for optimizing its treatment and slowing its progression.28 Some forms of cancer rehabilitation may reduce the risk and lessen the severity of this condition.29,30

Other long-term local effects of surgical and radiation treatment include numbness, tingling, or tightness in the chest wall, arms, or shoulders. Recent studies suggest that approximately one-third of women develop persistent pain after breast cancer surgery or radiation therapy,31 with younger women and those who undergo axillary lymph node dissection having the highest risk.32 In addition, treatment with chemotherapy can lead to premature menopause, which increases the risk of osteoporosis and
impaired fertility.\textsuperscript{33,34} Chemotherapy with taxanes often leads to neuropathy, which can persist long after treatment.\textsuperscript{35} Anthracyclines and HER2-targeted drugs can lead to cardiomyopathy and congestive heart failure.\textsuperscript{36} The American Society of Clinical Oncology recently issued guidelines for the prevention and monitoring of cardiomyopathies and other cardiovascular irregularities associated with these treatments.\textsuperscript{37} Treatment with aromatase inhibitors, which is generally reserved for postmenopausal women, can also cause osteoporosis as well as myalgia and arthralgia,\textsuperscript{38,39} whereas tamoxifen treatment can slightly increase the risk of endometrial cancer and thromboembolic disease.\textsuperscript{40,41} Hormonal treatments for breast cancer can also cause menopausal symptoms, such as hot flashes, night sweats, and atrophic vaginitis, which can lead to dyspareunia.\textsuperscript{42} Reports of sexual dysfunction are common in breast cancer survivors yet often go unaddressed.\textsuperscript{43} Breast cancer survivors may also experience cognitive impairments and chronic fatigue.\textsuperscript{29,44}

Colon and rectum

It is estimated that, as of January 1, 2019, there were more than 1.5 million men and women living in the United States with a previous colorectal cancer diagnosis, and 145,600 new cases will be diagnosed in 2019. Three-quarters (76\%) of colorectal cancer survivors—almost 1.2 million men and women—are aged 65 years and older, although there are 61,530 survivors (4\%) aged younger than 50 years (Fig. 2). The median age at diagnosis for colorectal cancer is 66 years for males and 69 years for females.\textsuperscript{7} Patients with rectal cancer tend to be younger at diagnosis than patients with colon cancer (median age, 63 years vs 69 years, respectively).

Treatment and survival

The majority of patients with stage I and II colon cancer undergo colectomy without chemotherapy (84\%), whereas approximately two-thirds of patients with stage III disease (as well as some patients with stage II disease) receive adjuvant chemotherapy to lower their risk of recurrence (Fig. 5).
For patients with rectal cancer, proctectomy or proctocolectomy is the most common treatment (61%) for those with stage I disease, with approximately one-half also receiving neoadjuvant radiation or chemotherapy (Fig. 6). Stage II and III rectal cancers are usually treated with neoadjuvant chemoradiotherapy and surgery. For some stage IV colon and rectal cancers with limited metastases, surgical treatment, usually with chemotherapy and/or radiation therapy, is an option. Several targeted drugs are also available to treat metastatic disease, and immunotherapy may be appropriate, depending on the tumor’s molecular characteristics. A colostomy (usually temporary) may be required, more often for patients with rectal cancer (29%) than for those with colon cancer (12%).

The 5-year relative survival rate for persons with colorectal cancer is 65% but is slightly higher for rectal cancer (67%) than for colon cancer (64%). For the 20% and 22% of patients diagnosed with stage I or II disease, respectively, 5-year relative survival rates are 91% and 82%, respectively. However, 5-year survival declines to 12% for stage IV disease.

**Short-term and long-term health effects**

Neuropathy is a common side effect of chemotherapy regimens typically used for colorectal cancer that contain oxaliplatin. Periodic or chronic diarrhea occurs in approximately one-half of colorectal cancer survivors. Bowel dysfunction (including increased stool frequency, incontinence, radiation proctitis, and perianal irritation) is common among rectal cancer survivors, especially those treated with pelvic radiation. Referral to a trained ostomy therapist may benefit patients with a colostomy. Survivors may also suffer from bladder dysfunction, sexual dysfunction, and negative body image. Ovarian transposition may be considered among reproductive-aged female patients wanting to preserve fertility before pelvic radiation.

**Leukemias and lymphomas**

There are an estimated 451,700 leukemia survivors living in the United States, and 61,780 people will be newly diagnosed with leukemia in 2019. Although leukemia is the most common type of cancer diagnosed among children aged birth to 14 years, the majority (92%) of patients with leukemia are diagnosed at age 20 years and older. Acute myeloid leukemia (AML) and chronic lymphocytic leukemia/small lymphocytic lymphoma (CLL/SLL; hereafter termed “CLL”) are the most common types of leukemia diagnosed in adults, whereas acute lymphocytic leukemia (ALL) is the most common leukemia diagnosed among children and teens. CLL is included among leukemias for the purpose of reporting trends, although it is now recognized as a type of lymphoma. The median age at diagnosis is 15 years for ALL, 65 years for chronic myeloid leukemia (CML), 69 years for AML, and 70 years for CLL.

There are 2 major types of lymphoma: Hodgkin lymphoma (HL) and NHL. NHL can be further divided into many subtypes that progress and respond differently to treatment. Prognosis and treatment depend on the stage and type of lymphoma. It is estimated that, as of January 1, 2019, there were 234,890 HL survivors and 757,720 NHL survivors. Approximately 8110 new cases of HL and 74,200 new cases of NHL will be diagnosed in 2019. Although NHL is a common childhood and adolescent cancer, similar to HL, the vast majority of NHL cases (98%) are diagnosed in adults. The median age at diagnosis is 39 years for HL and 67 years for NHL.

**Treatment and survival for the most common types of leukemia and lymphoma**

**Acute myeloid leukemia**

Chemotherapy is the standard treatment for AML, although many older adults, among whom the disease is most common, are not able to tolerate the most aggressive and potentially curative protocols. Patients may also undergo allogeneic stem cell transplantation, whereas some receive radiation therapy, often as part of a conditioning regimen before stem cell transplantation.

Approximately 60% to 85% of adults aged 60 years and younger with AML can expect to attain complete remission status after the first phase of treatment, and 35% to 40% of patients in this age group will be cured. In contrast, 40% to 60% of patients aged older than 60 years will achieve complete remission, and only 5% to 15% will be cured. For the small number of AML cases that occur in children and adolescents, the prognosis is substantially better. The 5-year relative survival for children and adolescents is 67%, but it declines to 54%, 32%, and 7% for patients aged 20 to 49 years, 50 to 64 years, and 65 years and older, respectively.

**Chronic myeloid leukemia**

CML (also called chronic myelogenous leukemia) is most common in adults, with only 2% of cases diagnosed in children and adolescents. The cancer cells in CML contain a characteristic fusion gene, BCR-ABL, caused by a translocation of genetic material between chromosomes 9 and 22, which can result in the Philadelphia chromosome. Modern treatment of CML has been transformed by tyrosine kinase inhibitors (TKIs) aimed at the BCR-ABL protein, which induce remission in most patients. In the past, it was thought that these drugs had to be taken indefinitely to keep the disease in check; however, recent studies have found they can be safely discontinued in a subset of patients. Stem cell transplantation may be used in younger patients and those who become resistant to TKIs, whereas chemotherapy is only used in TKI-resistant cases. Primarily because of the discovery and the
widespread use of BCR-ABL TKIs, the 5-year survival rate for CML increased from 31% for cases diagnosed during 1990 through 1992 to 69% for those diagnosed during 2008 through 2014.⁷,⁵⁹

Acute lymphocytic leukemia

More than one-half of ALL (also called acute lymphoblastic leukemia) cases (54%) are diagnosed in patients aged younger than 20 years.⁵⁴ Chemotherapy is the standard treatment for ALL. Approximately 20% to 30% of adult ALL cases and <5% of childhood cases are Philadelphia chromosome positive and may benefit from the addition of a BCR-ABL TKI to chemotherapy.⁶⁰,⁶¹ More than 95% of children and from 78% to 92% of adults with ALL attain remission.⁶² Allogeneic stem cell transplantation is recommended for some patients with high-risk disease characteristics and for those who relapse after remission or who fail to achieve remission after successive courses of induction chemotherapy. Chimeric antigen receptor (CAR) T-cell therapy is also an option for patients with a specific subtype of ALL who have relapsed or have not responded to other treatments.⁶³

Survival rates for ALL have increased significantly over the past 3 decades, particularly among children. Notably, the black-white relative survival disparity in children and adolescents with ALL has declined from a 16-percentage point difference during 1980 through 1982 (55% vs 71%, respectively) to an 8-percentage point difference during 2008 through 2014 (85% vs 93%, respectively).⁵⁷ Survival dramatically declines with increasing age; the current 5-year relative survival rate is 89% for ages birth to 19 years, 47% for ages 20 to 49 years, 28% for ages 50 to 64 years, and 17% for ages 65 years and older.⁶⁴

Chronic lymphocytic leukemia/small lymphocytic leukemia

CLL is the most common type of leukemia in adults, and 95% of cases are diagnosed in individuals aged 50 years and older.⁵⁴ Treatment is generally reserved for symptomatic patients or those who have cytopenia or other complications because the disease is slow-growing, treatment is unlikely to result in a cure, and it is not clear that treatment prolongs survival.⁵⁵–⁶⁷ Available treatments include chemotherapy, immunotherapy, targeted therapy, radiation therapy, and splenectomy. CAR T-cell immunotherapy has also been used in patients with disease that has relapsed or has not responded to other treatments.⁶³ The overall 5-year relative survival for CLL is 84%; however, there is large variation in survival among individual patients, ranging from several months to a normal life expectancy. Approximately 5% to 10% of patients with CLL also develop DLBCL, a process known as “Richter’s transformation.”⁶⁸

Hodgkin lymphoma

HL can be diagnosed at any age but is most common in early adulthood. There are 2 major types of HL. Classic HL is the most common and is characterized by the presence of Reed-Sternberg cells. Nodular lymphocyte-predominant HL (NLPHL), which is characterized by “popcorn cells,” comprises only approximately 5% of cases.⁵⁴ NLPHL is a more indolent disease, with a generally favorable prognosis.⁶⁹

Classic HL is generally treated with multiagent chemotherapy, sometimes in combination with radiation therapy, although the use of radiation therapy is declining.⁹ If these treatments are not effective, stem cell transplantation or treatment with the targeted antibody-drug conjugate brentuximab vedotin may be options. For patients with NLPHL, radiation alone may be appropriate for early-stage disease. For those with later-stage disease, chemotherapy plus radiation as well as the monoclonal antibody rituximab may be recommended. The 5-year survival rates for HL are 86% overall, 83% for classic HL, and 93% for NLPHL.

Non-Hodgkin lymphoma

The most common types of NHL are DLBCL, representing approximately 4 in 10 cases, and follicular lymphoma, representing approximately 1 in 5 cases.⁵⁴ Although DLBCLs grow quickly, most patients with localized disease and approximately 50% of those with advanced-stage disease are cured.⁷⁰,⁷¹ Overall, approximately 43% of patients with DLBCL receive chemotherapy plus immunotherapy (such as rituximab) with or without radiation (Fig. 7). Chemotherapy may also be used alone (32%) or may be followed with radiation therapy (7%).⁷² Approximately 14% of patients with DLBCL receive no initial treatment, although the percentage is higher for stage I versus stage IV disease (19% vs 14%, respectively).⁹ In contrast, follicular lymphomas tend to grow slowly and often do not require treatment until symptoms develop, but most are not curable.⁷³ Some cases of follicular lymphoma transform into DLBCL.
For NHL that persists or recurs after standard treatment, stem cell transplantation or CAR T-cell therapy may be an option. Five-year relative survival is 88% for follicular lymphoma and 63% for DLBCL.64

**Short-term and long-term health effects**

People treated for leukemia and lymphoma can experience several significant late effects. Some leukemia and lymphoma survivors, such as those treated with stem cell transplantation, have problems with recurrent infections and anemia, which may require blood transfusions. Certain chemotherapy drugs as well as the high-dose chemotherapy used for stem cell transplantation can lead to infertility. Allogeneic transplantation used to treat acute leukemias can lead to chronic graft-versus-host disease, which can cause skin changes, dry mucous membranes (eyes, mouth, vagina), joint pain, weight loss, shortness of breath, and fatigue.74

Chest radiation for HL increases the risk of cardiac dysfunction as well as breast cancer among women who were treated in childhood and adolescence.75,76 Patients with HL, NHL, and ALL are commonly treated with anthracyclines, which can also be cardiotoxic. In the past, some children with ALL at increased risk of central nervous system relapse received cranial radiation therapy. This treatment can cause long-term cognitive deficits; as such, clinical practice has evolved to use lower dosages than in the past in the instances in which it is used.77

**Lung and bronchus**

It is estimated that there are 571,340 men and women living in the United States with a history of lung cancer, and an additional 228,150 cases will be diagnosed in 2019. Approximately three-quarters of lung cancer survivors were aged 65 years or older as of January 1, 2019 (Fig. 2), reflecting the older median age at diagnosis (70 years).7 In part because of the low overall 5-year relative survival for the disease, most lung cancer survivors (60%) were diagnosed within the past 5 years.

**Treatment and survival**

Lung cancer is classified as small cell (SCLC) (13% of cases) or NSCLC (83% of cases) for the purposes of treatment (approximately 3% of cases lack information on histologic type).7 Because SCLC is rarely localized at diagnosis, surgical resection plays little role in its treatment, and most patients with SCLC receive chemotherapy.9 For the small number of patients with stage I and II NSCLC, the majority (56%) undergo surgery with either wedge resection (partial removal of a lobe of the lung), sleeve resection (removal of the tumor and a portion of the affected airways), lobectomy (entire removal of an affected lobe), or pneumonectomy (removal of one lung) (Fig. 8). In contrast, only 18% of patients with stage III NSCLC undergo surgery, whereas most (62%) are treated with chemotherapy and/or radiation. There are several targeted and immunotherapy drugs available to treat advanced NSCLC, but some are only useful in treating cancers with certain genetic mutations. In 2016, approximately 12% of patients with newly diagnosed stage IV NSCLC received immunotherapy. Targeted therapy drugs, such as angiogenesis inhibitors, epidermal growth factor receptor inhibitors, and anaplastic lymphoma kinase inhibitors, are also an important part of the treatment of NSCLC. Recently, immunotherapy drugs that act by targeting the programmed cell death receptors on T cells (programmed death-ligand 1 and programmed cell death protein 1 inhibitors) have been approved to treat some types of NSCLC as well as in combination with chemotherapy for SCLC.78

The 1-year relative survival for lung cancer increased from 34% for patients diagnosed during 1975 through 1977 to 47% for those diagnosed during 2011 through 2014,57 largely because of improvements in surgical techniques and chemoradiation. Because early disease is typically asymptomatic, the majority of lung cancers (61%) are diagnosed...
at stage III or IV; only 21% of cases are diagnosed at stage I (Fig. 4). The 5-year relative survival rate is 57% for patients with stage I disease and declines to 4% for those with stage IV disease. The 5-year relative survival for SCLC (6%) is lower than that for NSCLC (23%) for all stages combined as well for each stage.7

Short-term and long-term health effects

Many lung cancer survivors have impaired pulmonary function.79 In some cases, respiratory therapy and medications can improve fitness and allow survivors to resume normal daily activities. Treatment with epidermal growth factor receptor inhibitors can lead to a severe acneiform rash. Immunotherapy drugs used in lung cancer treatment can lead to several immune-mediated toxicities, including pneumonitis, colitis, nephritis, and endocrinopathy.

Lung cancer survivors who are current or former smokers are at increased risk of additional smoking-related cancers, especially in the head and neck and urinary tract, as well as second lung cancers and other smoking-related health problems. Survivors may feel stigmatized because of the social perception that lung cancer is a self-inflicted disease, which can be particularly difficult for those who never smoked.80 Data suggest that there is a benefit to smoking cessation even after a lung cancer diagnosis.81,82 Continuing to smoke can adversely affect survival, thus highlighting the importance of patient and clinician discussions regarding smoking status and cessation resources after a lung cancer diagnosis.83

Melanoma of the skin

It is estimated that there are more than 1.3 million skin melanoma survivors living in the United States, and 96,480 people will be newly diagnosed in 2019. Almost one-half (47%) of melanoma survivors (626,960 men and women) are aged younger than 65 years, including 207,750 survivors who are aged younger than 50 years (Fig. 2). The median age at diagnosis is 66 years,7 reflecting differences in occupational and recreational exposure to ultraviolet radiation by sex and age.

Treatment and survival

Surgery is the primary treatment for most melanomas. Patients with stage III melanomas may be offered adjuvant immunotherapy (nivolumab or pembrolizumab).84-86 Treatment for patients with stage IV melanoma has changed in recent years and typically includes immunotherapy (ipilimumab, pembrolizumab, and nivolumab) or targeted therapy drugs, which have been shown to extend survival.87-89 BRAF/MEK inhibitors have been shown to improve survival for melanoma with the BRAF gene mutation, which accounts for approximately one-half of all cases.90 Almost one-half of patients with metastatic disease who receive either chemotherapy or immunotherapy also receive radiation therapy.9

The 5-year relative survival for melanoma is 92%.7 More than one-half of melanomas are diagnosed at stage I, for which the 5-year relative survival approaches 100%.64 For the small proportion of patients diagnosed with stage IV cancer, however, 5-year survival is only 19%.

Short-term and long-term health effects

Depending on the size and location of the melanoma, removal of these cancers can be disfiguring. Male and female melanoma survivors are nearly 13 times and 16 times, respectively, more likely than the general population to develop additional melanomas because of skin type and other genetic or behavioral risk factors.91 Approximately 10% to 15% of patients treated with ipilimumab experience potentially fatal autoimmune-related side effects.92 Autoimmune-related side effects occur less often with pembrolizumab and nivolumab.93 Patients treated with BRAF inhibitors have an increased risk of developing squamous cell skin cancers,94 although this risk is attenuated in regimens that include the addition of an MEK inhibitor.95

Prostate

It is estimated that there are more than 3.6 million men with a past diagnosis of prostate cancer in the United States, and 174,650 cases will be newly diagnosed in 2019. The majority (82%) of prostate cancer survivors are aged older than 65 years, whereas less than 1% (29,050) are aged younger than 50 years (Fig. 2). The median age at diagnosis is 66 years.7

Treatment and survival

Treatment options vary, depending on the extent of disease and risk of recurrence, as well as patient characteristics such as age, comorbidity, and personal preferences. Active surveillance rather than immediate treatment is a commonly recommended approach for low-risk, localized cancer or for those patients who are older and/or who have other serious health conditions.96-98 After publication of the 2010 National Comprehensive Cancer Network guideline to minimize overtreatment of low-risk disease,99 active surveillance for such disease increased from 15% to 42% from 2010 to 2015 among men of all ages combined, whereas rates of radical prostatectomy (removal of the prostate) declined from 47% to 31%.100 Previous studies have suggested that the increase in active surveillance is most pronounced among men aged 75 years and older.101 For advanced disease, androgen deprivation therapy (ADT), chemotherapy, bone-directed therapy (such as zoledronic acid or denosumab), radiation, or a combination of these treatments may be
used. Newer forms of hormone therapy, such as abiraterone and enzalutamide, have been approved in recent years to treat advanced prostate cancer that is no longer responding to traditional hormone therapy.102,103

The 5-year relative survival for all stages combined increased from 83% in the late 1980s to 99% in the most recent time period (2008-2014),7 primarily reflecting the lead time and overdiagnosis associated with prostate-specific antigen screening. Most (90%) prostate cancers are discovered in the local or regional stages, for which the 5-year relative survival rate approaches 100% (summary stage is used for prostate cancer cases in cancer registry data). However, the 5-year relative survival for distant-stage disease declines to 30%.

**Short-term and long-term health effects**

Surgery and radiation therapy for prostate cancer are associated with the risk of substantial physical impairments, including urinary incontinence, erectile dysfunction, and bowel complications.104-107 In one long-term follow-up study, greater than 95% of patients with prostate cancer who received surgery or radiation experienced some sexual dysfunction, and approximately 50% reported urinary or bowel dysfunction.108 Patients receiving hormonal treatment may experience loss of libido, hot flashes, night sweats, irritability, and gynecomastia. Sexual counseling in this population can be helpful in restoring comfort with intimacy.43 In the long term, ADT also increases the risk of osteoporosis, obesity, and diabetes.109-112 Although some studies have found an increased risk of cardiovascular disease or death associated with the use of hormone therapy, the evidence is inconsistent.110,111,113 Careful monitoring of cardiovascular risk factors is recommended in men who have received ADT.114,115

**Testis**

It is estimated that there are 287,780 testicular cancer survivors in the United States, and an additional 9560 men
will be diagnosed in 2019. Testicular germ cell tumors (TGCTs) account for approximately 97% of all testicular cancers. The 2 main types of TGCTs are seminomas (13%) and nonseminomas (55%), with an additional 28% of tumors having a mixed histology of both cell types. Nonseminomas generally occur in men in their late teens to early 40s and tend to be more aggressive than seminomas. Seminomas are slow-growing and are generally diagnosed in men in their late 30s to early 50s.

**Treatment and survival**

Treatment of almost all TGCTs begins with orchiectomy. The most common treatment for stage I seminomas is inguinal orchiectomy without chemotherapy or radiation (71%), whereas many patients with stage II disease receive chemotherapy (62%), radiation (22%), or both (1%) after surgery (Fig. 9). Over the last decade, postsurgical active surveillance has become an increasingly preferred management option for patients with stage I seminomas, and long-term study results support this treatment strategy. Late-stage seminomas are generally treated with surgery and chemotherapy (64%) (Fig. 9). For men with stage I nonseminomas, more than one-half are treated with orchiectomy alone, whereas the majority of patients with stage II disease receive additional treatment after the initial surgical procedure, including chemotherapy (52%), retroperitoneal lymph node dissection (RPLND) (10%), or both (29%) (Fig. 9). Men with metastatic nonseminomas are usually treated with chemotherapy after orchiectomy with or without RPLND.

Testicular cancer survival has increased substantially since the mid-1970s, largely because of the success of chemotherapy regimens for advanced disease. The 5-year relative survival for testicular cancer is 99%. However, the 5-year relative survival is lower for nonseminomas (90%) than for mixed TGCTs (94%) and seminomas (99%), regardless of age. More than one-half (63%) of patients are diagnosed at stage I, for which the 5-year relative survival approaches 100%. The prognosis for metastatic testicular cancer is favorable compared with most other metastatic cancers, with a 5-year survival rate of 74%.

**Short-term and long-term health effects**

Although most men who have one healthy testicle produce sufficient male hormones and sperm to continue sexual relations and father children, sperm banking is recommended before treatment, although fertility may already be impaired. Consultation about fertility risks before treatment and referral for sperm banking as appropriate are important in efforts to promote quality-of-life outcomes.

RPLND can lead to retrograde ejaculation, making unassisted reproduction impossible. Men treated with chemotherapy have an increased risk of coronary artery disease as they age, and therefore these patients and their physicians should be particularly mindful of risk factors such as hyperlipidemia, hypertension, obesity, and smoking. Men who receive radiation therapy are at increased risk of developing a subsequent cancer. Men who have bilateral tumors have both testes removed and require lifelong testosterone supplementation.

**Thyroid**

It is estimated that there are 900,590 people living in the United States with a previous thyroid cancer diagnosis, and an additional 52,070 will be diagnosed in 2019. The majority of thyroid cancer survivors are women (78%), reflecting that the incidence in women is more than double that in men. The median age at diagnosis—55 years for males and 50 years for females—is younger than that for most other adult cancers.

**Treatment and survival**

Most thyroid cancers are either papillary or follicular carcinomas, which are highly curable, but approximately 3% are medullary or anaplastic carcinomas, which are more difficult to treat because they do not respond to radioactive iodine treatment. These types of thyroid cancers also grow more quickly and have often metastasized by the time they are diagnosed.

Initial treatment in nearly all cases of thyroid cancer is surgery, with most patients receiving total (81%) or partial thyroidectomy (15%). Approximately one-half of surgically treated patients with papillary or follicular thyroid cancer receive radioactive iodine (I-131) after surgery to destroy any remaining thyroid tissue and cancer. After total thyroidectomy, thyroid hormone therapy is required and is often prescribed in a dosage sufficient to inhibit pituitary production of thyroid-stimulating hormone to decrease the likelihood of recurrence.

Total thyroidectomy is the primary treatment for patients with medullary thyroid cancer. When the tumor is extensive or cannot be completely resected, radiation therapy may be given after surgery to try to reduce the risk of local recurrence. Targeted drugs can be useful in treating metastatic disease. Anaplastic thyroid cancers are often widespread and resistant to treatment. However, those with BRAF V600E mutations do respond to BRAF/MEK inhibitors. In selected cases, radiation therapy alone or in combination with chemotherapy may be used.

The 5-year relative survival rate for patients who had thyroid cancer diagnosed during 2008 through 2014 is 98%, although survival varies by age at diagnosis, stage, and histologic type. For medullary and anaplastic carcinomas, the 5-year relative survival rates are 90% and 7%, respectively.

**Short-term and long-term health effects**

Patients who undergo total thyroidectomy require thyroid hormone replacement therapy, and thyroid hormone levels
must be monitored to prevent hypothyroidism, which can cause cold intolerance and weight gain. Surgical removal of the thyroid gland can damage the underlying parathyroid glands, leading to problems with calcium metabolism. Surgery can also damage nerves to the larynx and lead to voice changes. For those treated with I-131, there is a low risk of temporary loss of or change in taste as well as early-onset or late-onset effects from damage to the salivary glands, such as dry mouth, dental caries, and dysphagia. Treatment with I-131 has also been found to increase the risk of subsequent cancers, particularly those of the salivary glands. Approximately 25% of medullary thyroid cancers occur as part of a genetic syndrome, such as multiple endocrine neoplasia type 2, and therefore these patients should be screened for other syndromic cancers and referred for genetic counseling and possible testing.

Urinary bladder
It is estimated that there are 829,620 urinary bladder cancer survivors living in the United States. The vast majority of bladder cancer survivors are men (75%), reflecting the 3-fold higher incidence in men; among the estimated 80,470 cases expected in 2019, 61,700 will be diagnosed in men. The median age at diagnosis is 72 years. More than 70% of patients with bladder cancer are diagnosed with non–muscle-invasive disease (ie, stage 0–1) (Fig. 4). Treatment and survival
For non–muscle-invasive cancers, most patients are diagnosed and treated with TURBT, which may be followed by intravesical chemotherapy or biological therapy with Bacillus Calmette-Guerin (BCG). Among patients with stage 0 disease, those with flat CIS are substantially more likely to receive BCG immunotherapy than those with non–invasive papillary carcinoma (38% vs 13%, respectively), reflecting the large proportion of low–grade tumors among the latter.Receipt of BCG among patients with high–grade noninvasive papillary carcinomas and CIS has been shown to be similar. The NCDB does not distinguish between systemic and intravesical chemotherapy but, based on treatment guidelines, it is likely that virtually all of the chemotherapy noted represents intravesical administration.

Among appropriately selected patients with nonmetastatic disease, TURBT followed by combined chemotherapy and radiation therapy is as effective as cystectomy at preventing recurrence. The vast majority (91%) of patients with stage I bladder cancer and two-thirds of those with stage II disease are diagnosed and treated with TURBT with or without chemotherapy and/or radiation (Fig. 10). In contrast, 68% of patients with stage III bladder cancer receive cystectomy with or without chemotherapy and/or radiation (Fig. 10). Chemotherapy is usually the first treatment for cancers that have metastasized, but other treatments might be used as well.

For all stages combined, the 5-year relative survival rate is 77%. Stage 0 urinary bladder cancer is diagnosed in 47% of cases, for which the 5-year relative survival is 95%. The 5-year relative survival is 79% for the 1 in 5 patients diagnosed with stage I disease and declines to 12% for those with stage IV disease.

Short-term and long-term health effects
Post-treatment surveillance is crucial given the high rate of recurrence. In one study, the 10-year prevalence of recurrence among patients with high-risk, non–muscle-invasive bladder cancer was 74%. Surveillance can include urine biomarker assays, urine cytology, and/or cystoscopy. Patients requiring repeated bladder surgeries can end up with a small or scarred bladder, which may lead to urinary frequency or incontinence. Partial cystectomy results in
a smaller bladder, sometimes causing the patient to have more frequent urination. Patients undergoing total cystectomy require urinary diversion with either construction of a neobladder with urethral anastomosis or a urostomy. Those with a neobladder retain most of their urinary continence after appropriate rehabilitation. However, creation of a neobladder remains much less common than urostomy (9% vs 91%), largely because of the technical complexity of the procedure; its utilization is substantially higher at larger, higher volume hospitals. Younger, healthier patients and those who are male are also more likely to undergo the procedure.

### Uterine corpus

There are an estimated 807,860 women living in the United States with a previous diagnosis of uterine corpus cancer, and 61,880 cases will be newly diagnosed in 2019. Cancer of the uterine corpus is often referred to as endometrial cancer because greater than 90% of cases arise in the endometrium. It is the second most prevalent cancer among women after breast cancer and has a median age at diagnosis of 62 years.

#### Treatment and survival

Surgery without chemotherapy or radiation, consisting of hysterectomy (often along with bilateral salpingo-oophorectomy), is used to treat 72% of patients with early-stage (stage I) disease. Approximately 25% of patients with stage I disease also receive radiation and/or chemotherapy in addition to surgery (Fig. 11). More than three-quarters (77%) of women with stage III disease and approximately one-half (51%) of those with metastatic disease undergo surgery followed by radiation and/or chemotherapy. Clinical trials are currently assessing the most appropriate regimen of radiation and chemotherapy for women with metastatic or recurrent cancers.

The 5-year relative survival for cancer of the uterine corpus is 81%. Approximately 6 in 10 cases are diagnosed at stage I (usually because of postmenopausal bleeding), for which the 5-year survival is 96%. The 5-year relative survival for white women (83%) is substantially higher than that for black women (62%) for all stages combined and is also higher for each stage.

#### Short-term and long-term health effects

Any hysterectomy causes infertility. Younger women with low-risk disease may elect to receive conservative surgical treatment. Bilateral oophorectomy will cause menopause in premenopausal women, which can lead to symptoms such as hot flashes, night sweats, atrophic vaginitis, and osteoporosis. Long-term side effects of radiation therapy for uterine cancer can include bladder and bowel dysfunction as well as atrophic vaginitis and vaginal stenosis. Sexual problems are commonly reported among uterine cancer survivors. Pelvic lymphadenectomy can lead to lower extremity lymphedema, particularly for women who also receive radiation.

### Cancers in children and adolescents

It is estimated that there were 65,850 cancer survivors aged birth to 14 years (children) and 47,760 survivors aged 15 to 19 years (adolescents) living in the United States as of January 1, 2019, and 11,060 children and 4990 adolescents will be newly diagnosed in 2019. Leukemia survivors account for approximately one-third of all cancer survivors aged younger than 20 years. Previously published estimates of childhood and adolescent cancer prevalence that include adults approach 400,000 survivors, a dramatic reflection of the high overall survival rates for this population in recent decades.

#### Treatment and survival

Pediatric cancers can be treated with a combination of therapies chosen based on the type and stage of cancer. Treatment often occurs in specialized centers and is coordinated by a multidisciplinary team including pediatric
oncologists, surgeons, nurses, social workers, child life specialists, psychologists, and others.

Adolescents (ages 15-19 years) diagnosed with cancers that are more common in childhood are usually most appropriately treated at pediatric facilities or by pediatric specialists. For example, studies have shown that pediatric protocols result in better outcomes for adolescent patients with ALL than adult protocols.\(^\text{140}\) In addition, childhood cancer centers are more likely than adult cancer centers to offer adolescent patients the opportunity to participate in clinical trials.\(^\text{141}\) For adolescent patients with cancers that are more common among adults, such as melanoma, testicular cancer, and thyroid cancer, treatment by adult care specialists is more appropriate.\(^\text{142}\)

The overall 5-year relative survival rate for all patients with childhood cancers (those aged birth to 14 years) combined has improved markedly over the past 30 years, from 58% for cases diagnosed between 1975 and 1979 to 84% for cases diagnosed between 2008 and 2014, because of new and improved treatments. The current 5-year relative survival rate for adolescents (85%) is similar to that for children.\(^\text{7}\) Childhood and adolescent cancer survival rates vary considerably, depending on cancer type and age at diagnosis. For example, the 5-year ALL survival is 91% for children versus 74% for adolescents.

**Short-term and long-term health effects**

Childhood cancer survivors may experience both long-term and late effects. Aggressive treatments used for childhood cancers, especially in the 1970s and 1980s, resulted in several late effects, including increased risk of subsequent neoplasms and cardiomyopathies.\(^\text{143}\) A large follow-up study of pediatric cancer survivors found that almost 10% developed a second cancer (most commonly female breast, thyroid, and bone) over the 30-year period after the initial diagnosis.\(^\text{144}\) In addition, a subsequent study of the same childhood cancer survivor cohort found that 54% had developed a severe or life-threatening chronic health condition by age 50 years, compared with 20% of the survivors’ cancer-free siblings.\(^\text{145}\) Among childhood cancer survivors diagnosed and treated between 1962 and 2001, 65% of those who were exposed to toxic pulmonary treatments experienced pulmonary dysfunction, and 57% of those exposed to potentially cardiotoxic therapies experienced cardiac abnormalities. A recent study showed that even childhood cancer survivors exposed to low doses of radiation treatment had a 1.6-fold risk of developing cardiac disease over the next 30 years if the area of exposure included more than one-half of the heart.\(^\text{146}\)

Recent declines in late morbidity and mortality among childhood cancer survivors are due in part to the reduced use of certain treatments, such as cranial radiation for ALL and abdominal radiation for Wilms tumor.\(^\text{147}\) However, even many newer, less toxic therapies increase the risk of serious health conditions.\(^\text{148}\) Cognitive impairment affects up to one-third of childhood cancer survivors.\(^\text{149}\) In addition, some chemotherapies and surgery and radiation affecting the reproductive organs may cause infertility in male and female patients.\(^\text{150,151}\) The potential impact on fertility and plans for fertility preservation should be discussed before commencing treatment. Treatment may delay maturation and normal development in survivors and also may lead to negative body image and psychological distress.\(^\text{152}\) Persistent effects of childhood cancer may result in survivors failing to achieve desired social or educational goals or mental health well-being comparable to those among peers without a cancer history.\(^\text{139,153,154}\) Given the extent of long-term and late effects among childhood cancer survivors, the Children’s Oncology Group, a National Cancer Institute–supported clinical trials group that cares for greater than 90% of US children and adolescents diagnosed with cancer, has developed guidelines for the screening and management of these individuals (survivorshipguidelines.org).

**Racial/Ethnic Disparities**

Substantial racial/ethnic disparities persist in cancer treatment and survivorship. Even after accounting for differences in stage at diagnosis, the 5-year relative survival is lower for blacks compared with whites for most cancers.\(^\text{1}\) Studies have found that a substantial proportion of these disparities are driven by health insurance differences.\(^\text{24,25}\) Underrepresentation of racial/ethnic minorities in large clinical trials has also been identified as a major barrier to health equity in cancer treatment.\(^\text{155}\) In the posttreatment phase, black cancer survivors report poorer physical functioning and less access to culturally appropriate support services compared with white survivors and receive inadequate posttreatment surveillance.\(^\text{156,157}\) For example, in one population-based study of posttreatment colorectal cancer survivors, black patients were 24% less likely than whites to undergo surveillance colonoscopy.\(^\text{158}\) Further research on racial/ethnic disparities in cancer survivorship is needed to identify and equitably disseminate effective public health measures to address these issues.

**Quality of Life and Other Concerns in Survivorship**

Although quality of life and functional status may decline considerably during and shortly after active cancer treatment, side effects and impairments are often acute and short-lived. Supportive care, including psychosocial and palliative care and cancer rehabilitation, can improve pain, functioning, and overall quality of life throughout every stage of survivorship.\(^\text{159}\) However, other effects of cancer and its treatment may be persistent and can become chronic, and some, often referred to as late effects, may emerge months or even years...
after the completion of primary cancer treatment. The type and prevalence of these side effects vary with clinical factors (eg, cancer type, treatment) and patient characteristics (eg, age, sex, comorbidity). Although emotional well-being is generally comparable to that of those with no history of cancer for longer term survivors (5 years or more), significant numbers report lower overall physical well-being than their peers.2,160 The most common side effects of cancer and its treatment are pain, fatigue, and emotional distress.161-163 Among survivors diagnosed at a young age, long-term and late effects, such as subsequent cancers, neurological sequelae, cardiomyopathies, sexual development and/or dysfunction, and fertility impairment, are of particular concern. However, information on these late and long-term side effects at the population level is limited. Efforts to link information on health-related quality of life and patient-reported outcomes with population-based cancer registry data to facilitate the surveillance of long-term and late effects are ongoing.164

Cancer survivors are vulnerable to financial hardships that may manifest as material (eg, problems paying medical bills, medical debt, and bankruptcy), psychological (eg, stress or worry about paying medical bills), or behavioral (eg, delaying or forgoing necessary medical care because of cost) aspects. Survivors who are younger, underinsured or uninsured, and/or have lower income are more likely to experience financial hardship, as are long-term survivors of childhood cancer.165-168 For example, in one study, approximately 35% of cancer survivors aged 18 to 49 years reported difficulty in paying medical bills compared with 25% in those without a history of cancer; this gap narrowed substantially in those aged 50 to 64 years (27% vs 23%, respectively).167 There is increasing emphasis on improving cancer survivors’ overall well-being and quality of life through the application of cancer rehabilitation; psychosocial interventions; principles of disease self-management; and the promotion of healthy lifestyles, such as avoiding tobacco, maintaining a healthy body weight, avoiding intense ultraviolet radiation exposure, and being physically active throughout life. Several practical interventions have been developed for diet, weight, and physical activity among cancer survivors.169 Support for smoking cessation and increased access to cessation aids are essential, as approximately 10% of cancer survivors continue to smoke even up to 9 years after diagnosis.170 Younger cancer survivors in particular have been shown to have a higher prevalence of smoking after diagnosis than the general population; from 2008 to 2017, 31% of cancer survivors aged 18 to 44 years were current smokers, compared with 19% of the general population.171

Quality-of-life issues also encompass the concerns of informal caregivers, who provide substantial emotional and physical support to survivors. Caregivers frequently report having unmet psychosocial and medical needs and are vulnerable to depression, anxiety, and psychological distress. In one study, approximately 40% of caregivers reported that they found caregiving emotionally difficult, and 12% reported experiencing depression.172 Social support programs for caregivers that teach coping skills have been shown to diminish the negative impact of caregiver stress.173-175

It is important for health care providers to understand the unique medical and psychosocial needs of survivors and their caregivers and to be aware of resources that can assist in navigating the various phases of cancer survivorship. The American College of Surgeons CoC has issued standards for quality, patient-centered cancer care that include recommendations for patient navigation, palliative care, distress management, and survivorship care planning.176 The Alliance for Quality Psychosocial Cancer Care, a coalition of professional and advocacy organizations including the American Cancer Society, was formed to advance these recommendations and has issued a comprehensive resource guide available to assist CoC-accredited facilities in meeting the new standards.177 Several organizations and associations, including the National Comprehensive Cancer Network and the American Cancer Society, have begun to produce guidelines to assist primary care physicians in the provision of supportive and ongoing care for people with a history of cancer. In addition, the American Cancer Society has set forth a “blueprint” to describe 3 priority areas for improving health and quality of life for long-term cancer survivors and their caregivers and reducing the costs of care, including: 1) implementing routine needs assessment of survivors and caregivers; 2) facilitating personalized information and referrals from diagnosis onward for both survivors and caregivers, tailoring the intensity and setting of care based on needs, and shifting care out of clinicians’ offices to home and community settings wherever possible; and 3) disseminating and supporting the implementation of new care methods and interventions.178

Limitations
Cancer prevalence estimates cannot be compared with previously published estimates because they are model-based projections based on current population-based incidence, mortality, and survival trends. In addition, the NCDB is a compilation of data from hospital registries and may not be representative of all patients treated in the United States, especially those of low socioeconomic status. Data are also less complete for cancers that may be treated in the outpatient setting (eg, melanomas, chronic leukemia, and non–muscle-invasive bladder cancers). Data may also be less complete for therapies frequently administered in the outpatient setting, such as hormonal treatments. Furthermore, data are collected for patients diagnosed or treated at CoC-accredited facilities, which are more likely to be located in
larger urban areas compared with non–CoC-accredited facilities. Despite these limitations, studies have shown that disease severity and treatment patterns for common cancer sites in the NCDB stratified by clinical and sociodemographic factors are remarkably similar to those found in population-based registries. 179,180

Conclusions
Despite increasing awareness of survivorship issues and the resiliency of cancer survivors, many challenges remain. These include a fractured health care system; poor integration of survivorship care between the oncology and primary care settings; clinician workforce shortages and knowledge gaps about the needs of cancer survivors; lack of strong evidence-based guidelines for posttreatment care; and financial and other barriers to quality care, particularly among the medically underserved. To address these challenges, ongoing efforts to identify best practices for the delivery of quality cancer rehabilitation and posttreatment care are needed. Future research should also focus on identifying best practices for engaging cancer survivors in adopting and maintaining a healthy lifestyle at the policy, health care system, and individual patient levels. Models for the integration of comprehensive care for cancer survivors and their caregivers, including self-management, wellness and healthy lifestyle promotion, and cancer rehabilitation, are beginning to emerge. As the evidence base grows, efforts at the individual, provider, system, and policy levels will help cancer survivors live longer and healthier lives.

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