

Cancer Treatment and Survivorship Statistics, 2012

Rebecca Siegel, MPH¹; Carol DeSantis, MPH²; Katherine Virgo, PhD, MBA³; Kevin Stein, PhD⁴; Angela Mariotto, PhD⁵; Tenbroeck Smith, MA⁶; Dexter Cooper, MPH⁷; Ted Gansler, MD, MBA, MPH⁸; Catherine Lerro, MPH⁹; Stacey Fedewa, MPH¹⁰; Churchieh Lin, PhD, MBA¹¹; Corinne Leach, PhD, MPH¹²; Rachel Spillers Cannady, BS¹³; Hyunsoon Cho, PhD¹⁴; Steve Scoppa, BS¹⁵; Mark Hachey, MS¹⁶; Rebecca Kirch, JD¹⁷; Ahmedin Jemal, DVM, PhD¹⁸; Elizabeth Ward, PhD¹⁹

Although there has been considerable progress in reducing cancer incidence in the United States, the number of cancer survivors continues to increase due to the aging and growth of the population and improvements in survival rates. As a result, it is increasingly important to understand the unique medical and psychosocial needs of survivors and be aware of resources that can assist patients, caregivers, and health care providers in navigating the various phases of cancer survivorship. To highlight the challenges and opportunities to serve these survivors, the American Cancer Society and the National Cancer Institute estimated the prevalence of cancer survivors on January 1, 2012 and January 1, 2022, by cancer site. Data from Surveillance, Epidemiology, and End Results (SEER) registries were used to describe median age and stage at diagnosis and survival; data from the National Cancer Data Base and the SEER-Medicare Database were used to describe patterns of cancer treatment. An estimated 13.7 million Americans with a history of cancer were alive on January 1, 2012, and by January 1, 2022, that number will increase to nearly 18 million. The 3 most prevalent cancers among males are prostate (43%), colorectal (9%), and melanoma of the skin (7%), and those among females are breast (41%), uterine corpus (8%), and colorectal (8%). This article summarizes common cancer treatments, survival rates, and posttreatment concerns and introduces the new National Cancer Survivorship Resource Center, which has engaged more than 100 volunteer survivorship experts nationwide to develop tools for cancer survivors, caregivers, health care professionals, advocates, and policy makers. *CA Cancer J Clin* 2012;00:000-000. Published 2012 American Cancer Society.[†]

Introduction

Cancer is a major public health problem in the United States and many other parts of the world. Currently, one in 3 women and one in 2 men in the United States will develop cancer in his or her lifetime. Increases in the number of individuals diagnosed with cancer each year, due in large part to aging and growth of the population, as well as improving survival rates, have led to an ever-increasing number of cancer survivors. There are several definitions of cancer survivors; here, we use the term “cancer survivor” to describe any person who has been diagnosed with cancer, from the time of diagnosis through the balance of life. There are at least 3 distinct phases associated with cancer survival, including the time from diagnosis to the end of initial treatment, the transition from treatment to extended survival, and long-term survival.¹

The goal of treatment is to “cure” the cancer, or prolong survival in patients with advanced disease, while preserving the highest possible quality of life in both the long and short term. Many survivors, even among those who are cancer free, must cope with the long-term effects of treatment, as well as psychological concerns such as fear of recurrence. Cancer patients

¹Manager, Surveillance Information, Surveillance Research, American Cancer Society, Atlanta, GA; ²Epidemiologist, Surveillance Research, American Cancer Society, Atlanta, GA; ³Managing Director, Health Services Research, American Cancer Society, Atlanta, GA; ⁴Managing Director, Behavioral Research Center, American Cancer Society, Atlanta, GA; ⁵Chief, Data Modeling Branch, Surveillance Research, Division of Cancer Control and Population Sciences, National Cancer Institute, Bethesda, MD; ⁶Director, Behavioral Research Center, American Cancer Society, Atlanta, GA; ⁷Research Analyst, Behavioral Research Center, American Cancer Society, Atlanta, GA; ⁸Director of Medical Content, Health Promotions, American Cancer Society, Atlanta, GA; ⁹Epidemiologist, Health Services Research, American Cancer Society, Atlanta, GA; ¹⁰Program Manager, Health Services Research, American Cancer Society, Atlanta, GA; ¹¹Epidemiologist, Health Services Research, American Cancer Society, Atlanta, GA; ¹²Director, Cancer and Aging Research, Behavioral Research Center, American Cancer Society, Atlanta, GA; ¹³Behavioral Scientist, Behavioral Research Center, American Cancer Society, Atlanta, GA; ¹⁴Mathematical Statistician, Data Modeling Branch, Surveillance Research Program, Division of Cancer Control and Population Sciences, National Cancer Institute, Bethesda, MD; ¹⁵Senior Systems Analyst, Information Management Services Inc, Silver Springs, MD; ¹⁶Statistical Programmer, Information Management Services Inc, Silver Springs, MD; ¹⁷Director, Quality of Life and Survivorship, Cancer Control Science, American Cancer Society, Atlanta, GA; ¹⁸Vice President, Surveillance Research, American Cancer Society, Atlanta, GA; ¹⁹National Vice President, Intramural Research, American Cancer Society, Atlanta, GA.

Corresponding author: Rebecca Siegel, MPH, Surveillance Information, Surveillance Research, American Cancer Society, 250 Williams St, NW, Atlanta, GA 30303-1002; rebecca.siegel@cancer.org

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and survivors also face a variety of medical and social concerns dependent on their age, comorbid conditions, socioeconomic status, and family/support network. Throughout this article, the terms “cancer patient” and “survivor” are used interchangeably. It is important to note that not all individuals with a cancer diagnosis identify with the term “cancer survivor.”

In this article, we provide statistics on cancer prevalence, common treatment modalities, and survival and review issues related to cancer treatment and survivorship.

Materials and Methods

Prevalence Estimates

Cancer prevalence was projected using the Prevalence, Incidence Approach Model method, which calculates prevalence from cancer incidence and survival and all-cause mortality.² Incidence and survival were modeled by cancer type, patient sex, and age group using malignant cases diagnosed from 1975 through 2007 from the 9 oldest registries in the Surveillance, Epidemiology, and End Results (SEER) program. The most recent year of available data (2008) was excluded due to anticipated undercounts because of reporting delay. Survival was assumed to be constant from 2007 through 2022 and was estimated by fitting a parametric mixture cure survival model to the SEER data. Mortality data for 1969 through 2008 were obtained from the National Center for Health Statistics and projected mortality rates for 2009 to 2022 were obtained from the University of California at Berkeley mortality cohort life tables (available at: demog.berkeley.edu/~bmd/). Population projections from 2008 through 2022 were obtained from the US Census Bureau. For more information about this method, see studies by Mariotto et al.^{3,4}

Case Estimates for 2012

The method for estimating the number of new US cancer cases in 2012 is described elsewhere.⁵ Briefly, the total number of cases in each state was estimated using a spatiotemporal model based on incidence data from 47 states and the District of Columbia for the years 1995 through 2008 that met the North American Association of Central Cancer Registries' high-quality data standard for incidence, which covers about 95% of the US population. The numbers of new cases nationally and in each state were then projected 4 years ahead using a temporal projection method.

Staging

A number of different staging systems are used to classify cancers. The TNM staging system assesses cancer in 3 ways: the size and extension of the tumor (T), regional lymph node involvement (N), and the presence of distant metastases (M).

Once the T, N, and M classifications are determined, a stage of 0, I, II, III, or IV is assigned. The TNM staging system is commonly used in clinical settings and is used in this article for the description of treatment patterns. Summary stage, a less complex staging system, has historically been used by central cancer registries. Cancers are classified as in situ, local, regional, and distant, based on the extent of spread. The summary stage is used in this article to describe population-based patterns of stage at diagnosis and survival.

Survival

This article presents relative survival rates to describe cancer survival. Relative survival adjusts for normal life expectancy by comparing survival among cancer patients with that of the general population controlling for age, race, and sex. The 5-year survival statistics presented herein were originally published in the *SEER Cancer Statistics Review, 1975-2008*⁶ and are for diagnosis years 2001 to 2007, with all patients followed through 2008. In addition to 5-year relative survival rates, 1-year, 10-year, and 15-year survival rates are presented for selected cancer sites. These survival statistics were generated using the National Cancer Institute (NCI)'s SEER 17 database⁷ and SEER*Stat software (version 7.0.5).⁸ One-year survival rates are based on cancer patients diagnosed from 2004 through 2007, 10-year survival rates are based on diagnoses from 1995 to 2007, and 15-year survival rates are based on diagnoses from 1990 to 2007; all patients were followed through 2008. Caution should be exercised in interpreting increasing trends in survival rates. For example, increases in cancer screening rates can artificially improve survival statistics by shifting diagnosis earlier (ie, lead time bias) and detecting indolent cancers (ie, overdiagnosis).

Treatment

We analyzed cancer treatment data from 2 sources: the National Cancer Data Base (NCDB) and the SEER-Medicare linked database.

National Cancer Data Base

The NCDB is a hospital-based cancer registry jointly sponsored by the American Cancer Society (ACS) and the American College of Surgeons, and includes approximately 70% of all malignant cancers in the United States from more than 1400 facilities accredited by the American College of Surgeons' Commission on Cancer (CoC).⁹ Although chemotherapy use data in the NCDB are less complete than data on surgery or radiation therapy and information concerning specific chemotherapeutic agents is not available, the data are sufficiently complete to permit descriptive studies of cancer treatment patterns by site and stage. For more information regarding the classification of anticancer drugs into the categories of chemotherapy,

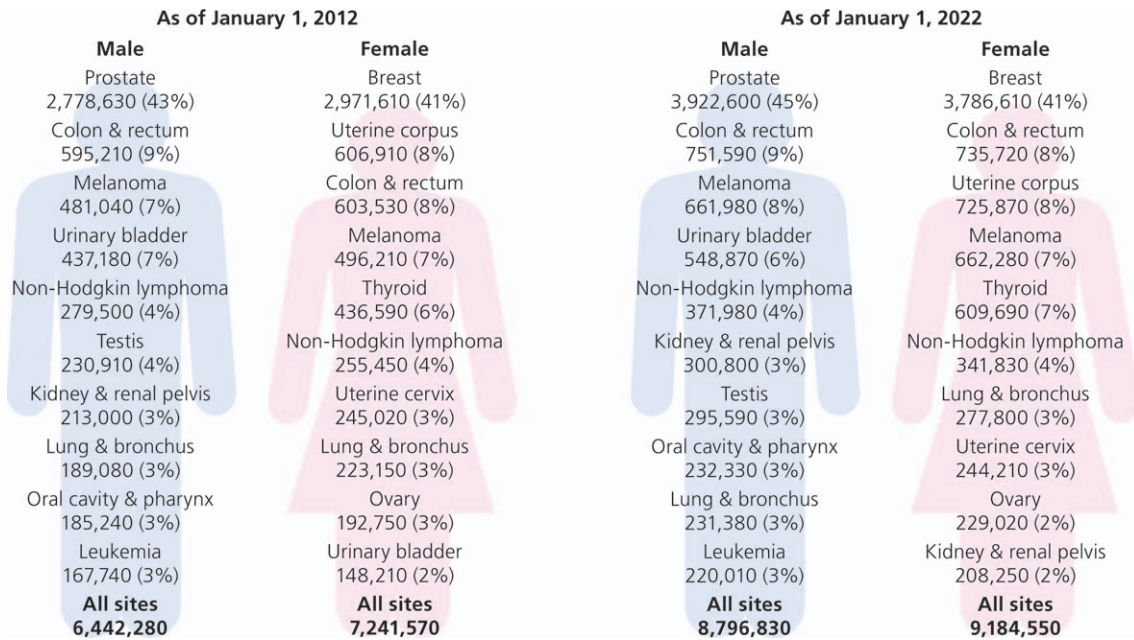


FIGURE 1. Estimated Numbers of US Cancer Survivors by Site.

immunotherapy, hormonal therapy, and targeted therapy, see the SEER-Rx Web site (available at: seer.cancer.gov/tools/seerrx).

Although the NCDB is a useful tool for describing cancer treatment at a national level, it may not be fully representative of all cancer patients treated in the United States. Data are collected for patients diagnosed or treated at CoC-accredited facilities, which are more likely to be located in urban areas and tend to be larger centers compared with non-CoC-accredited facilities.¹⁰ Additionally, cancers that are commonly treated and diagnosed in nonhospital settings (eg, melanoma, prostate cancer, and non-muscle-invasive bladder cancer) are less likely to be captured by the NCDB because it is a hospital-based registry. Although the NCDB is not population-based, trends in disease severity and treatment of common cancer sites are similar to those found in studies using SEER and SEER-Medicare data.¹¹⁻¹³ More information on the NCDB can be found at their Web site (facs.org/cancer/ncdb).

SEER-Medicare Database

The SEER-Medicare database is a large, integrated population-based cancer registry and claims data set.^{14,15} This database was accessed to supplement data not available in NCDB such as data regarding the use of specific chemotherapeutic agents. The SEER registries collect clinical, demographic, and cause-of-death information for persons with cancer and cover the states of Connecticut, Hawaii, Iowa, New Mexico, Utah, Kentucky, Louisiana, New Jersey, and California, as well as the metropolitan areas of Detroit, Atlanta, Seattle, and rural Georgia, capturing approximately

26% of the US population. Medicare is the primary health insurer for 97% of the US population aged 65 years and older. Medicare data include inpatient, outpatient, physician services, home health, durable medical equipment, and prescription drug claims files. The linkage of these 2 data sources is the collaborative effort of the NCI, the SEER registries, and the Centers for Medicare and Medicaid Services. More information on the SEER-Medicare database can be found at their Web site (available at: healthservices.cancer.gov/seermedicare).

Selected Findings

Cancer Prevalence

An estimated 13.7 million Americans with a history of cancer were alive on January 1, 2012. This estimate does not include carcinoma in situ of any site except the urinary bladder, and does not include basal cell and squamous cell skin cancers. The 10 most common cancer sites represented among survivors are shown in Figure 1. The 3 most common cancers among male survivors are prostate (43%), colorectal (9%), and melanoma of the skin (7%). Among female survivors, the most common cancers are those of the breast (41%), uterine corpus (8%), and colorectum (8%). The majority of cancer survivors (64%) were diagnosed 5 or more years ago, and 15% were diagnosed 20 or more years ago (Table 1). Nearly one-half (45%) of cancer survivors are aged 70 years or older, while only 5% are younger than 40 years (Table 2). As of January 1, 2022, it is estimated that the population of cancer survivors will increase to nearly 18 million (8.8 million males and 9.2 million females).

TABLE 1. Estimated US Cancer Prevalence as of January 1, 2012 by Sex and Time Since Diagnosis^a

YEARS SINCE DIAGNOSIS	MALE			FEMALE		
	NO.	PERCENTAGE	CUMULATIVE PERCENTAGE	NO.	PERCENTAGE	CUMULATIVE PERCENTAGE
0 to < 5	2,608,320	40%	40%	2,339,950	32%	32%
5 to < 10	1,628,010	25%	65%	1,595,410	22%	54%
10 to < 15	997,060	15%	80%	1,135,160	16%	70%
15 to < 20	570,290	9%	89%	791,880	11%	81%
20 to < 25	305,140	5%	94%	536,670	7%	88%
25 to < 30	154,470	2%	96%	343,300	5%	92%
30+	179,010	3%	100%	499,210	7%	100%

^aPercentages do not sum to 100% due to rounding.

Selected Cancers

Breast (Female)

It is estimated that there are nearly 3 million women living in the United States with a history of invasive breast cancer, and an additional 226,870 women will be diagnosed in 2012. The median age at the time of breast cancer diagnosis is 61 years (Fig. 2).⁶ About 20% of breast cancers occur among women aged younger than 50 years, while 40% occur among women aged 65 years and older. Overall, 60% of breast cancers are diagnosed at a localized stage.

Treatment and Survival

Surgical treatment for breast cancer involves breast-conserving surgery (BCS) or mastectomy. When BCS is appropriately used for localized or regional cancers, long-term survival is the same as with mastectomy.¹⁶ However, some patients require mastectomy because of large or multiple tumors and others elect mastectomy because of a reluctance or inability to undergo radiation therapy after BCS or for other reasons. Depending on age at diagnosis, 20% to 45% of women who undergo mastectomy elect to have breast reconstruction, either with an implant, tissue flap, or a combination of the 2.¹⁷⁻²¹

Among women diagnosed with early stage (I or II) breast cancer, 57% undergo BCS, 36% have mastectomy, 6% undergo no surgical treatment, and about 1% do not receive any treatment (Fig. 3). In contrast, among women with late stage (III or IV) breast cancer, 13% receive BCS, 60% undergo mastectomy, 18% do not have surgery, and 7% do not receive any treatment. The majority of women with early stage breast cancer who undergo BCS receive adjuvant treatment; nearly one-half undergo radiation therapy alone and one-third receive both radiation therapy and chemotherapy. In contrast, most women diagnosed with late stage disease undergo chemotherapy in addition to surgery and other therapies.

The overall 5-year relative survival rate for female breast cancer patients has improved from 75.1% between 1975 to 1977 to 90.0% for 2001 through 2007. This increase is due largely to improvements in treatment (ie, chemotherapy and hormone therapy) and to earlier diagnosis resulting from the widespread use of mammography.²²

The 5-year relative survival rate for women diagnosed with localized breast cancer is 98.6%; survival declines to 83.8% for regional stage and 23.3% for distant stage. In addition to stage, factors that influence survival include tumor grade, hormone receptor status, and human epidermal growth factor receptor 2 (HER2) status.

TABLE 2. Estimated US Cancer Prevalence as of January 1, 2012 by Sex and Age at Diagnosis^a

AGE, YEARS	MALE			FEMALE		
	NO.	PERCENTAGE	CUMULATIVE PERCENTAGE	NO.	PERCENTAGE	CUMULATIVE PERCENTAGE
All ages	6,442,280			7,241,570		
0-14	36,770	1%	1%	21,740	< 1%	< 1%
15-19	24,860	< 1%	2%	23,810	< 1%	1%
20-29	74,790	1%	3%	105,110	1%	2%
30-39	134,630	2%	5%	250,920	3%	5%
40-49	350,350	5%	10%	647,840	9%	14%
50-59	930,140	14%	24%	1,365,040	19%	33%
60-69	1,705,730	26%	50%	1,801,430	25%	58%
70-79	1,858,260	29%	79%	1,607,630	22%	80%
80+	1,326,740	21%	100%	1,418,050	20%	100%

^aPercentages do not sum to 100% due to rounding.

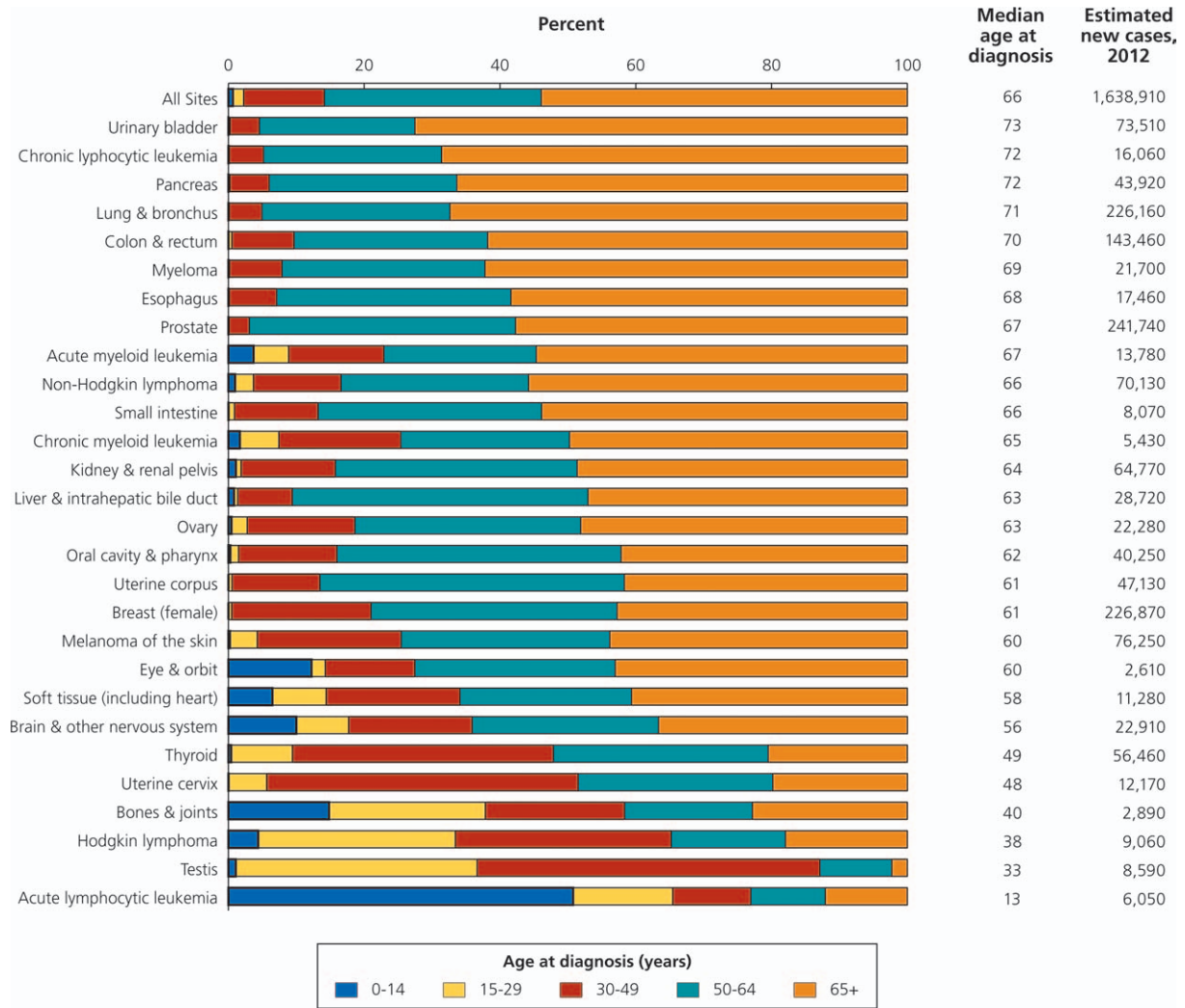


FIGURE 2. Age Distribution (Shown as %), Median Age at Diagnosis (in Years), and Estimated Number of New Cases by Tumor Site.

Note that the sites are ranked in order of median age at diagnosis from oldest to youngest.
Data source: SEER 17 registries.

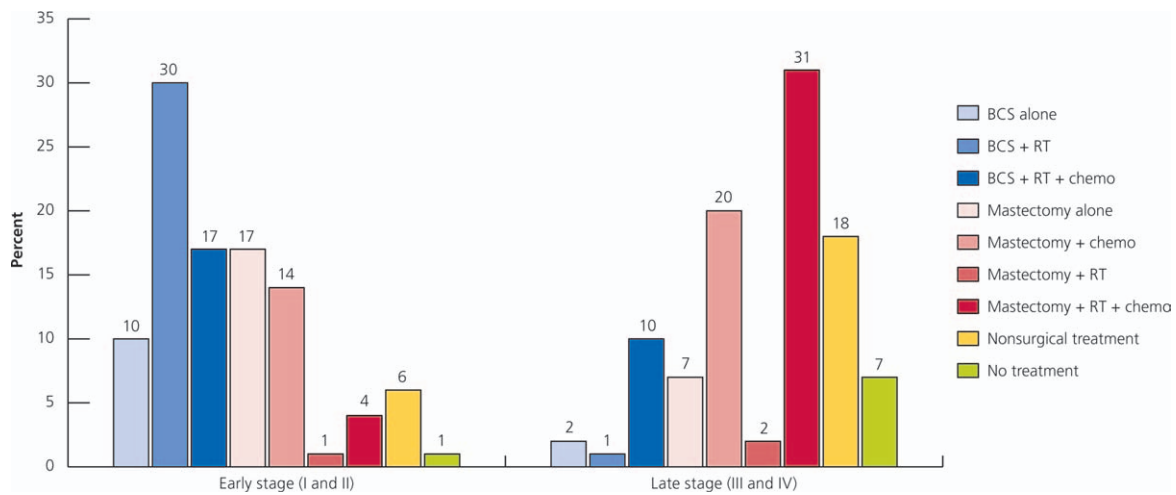


FIGURE 3. Female Breast Cancer Treatment Patterns by Stage, 2008.

BCS indicates breast-conserving surgery; RT, radiation therapy; chemo, chemotherapy (may include common targeted therapies). Percentages do not sum to 100% due to rounding.
Data source: NCDB.

African American women are less likely than white women to be diagnosed with local stage breast cancer (51% vs 61%) and have lower survival rates than white women within each stage of disease. The reasons for these differences are complex, but may be explained in large part by a combination of socioeconomic factors, less access to care among African American women, and biological differences in cancers.

Common Side Effects of Treatment

Lymphedema of the arm is a common side effect of breast cancer surgery and radiation therapy; it has been estimated that 10% to 50% of patients with breast cancer develop lymphedema.²³ The use of sentinel lymph node biopsy, rather than axillary lymph node dissection, reduces the risk of developing lymphedema. There are a number of effective therapies for lymphedema. Some evidence suggests that upper body exercise and physical therapy may reduce the risk and lessen the severity of this condition.²⁴

Other long-term local effects of breast cancer surgery and radiation treatment include numbness or tightness and pulling or stretching in the chest wall, arms, or shoulders. In addition, women diagnosed and treated for breast cancer at younger ages may experience impaired fertility and premature menopause and are at an increased risk of osteoporosis. Treatment with aromatase inhibitors can also cause osteoporosis, as well as muscle pain, and joint stiffness and/or pain.

Cancers in Children

Childhood cancers (from birth to age 14 years) are rare, representing less than 1% of all new cancer diagnoses, but they are the second leading cause of death in children, exceeded only by accidents. It is estimated that there are 58,510 survivors of childhood cancer living in the United States, and an additional 12,060 children will be diagnosed in 2012. The most common cancers in children are leukemia (34%), brain and other nervous system malignancies (27%), neuroblastoma (7%), Wilms tumor (5%), non-Hodgkin lymphoma (NHL) (4%) and Hodgkin lymphoma (HL) (4%), rhabdomyosarcoma (3%), retinoblastoma (3%), osteosarcoma (3%), and Ewing sarcoma (1%).⁶

Treatment and Survival

Childhood cancers are treated with a combination of therapies (surgery, radiation, and chemotherapy) chosen based on the type and stage of cancer. Treatment most commonly occurs in specialized centers and is coordinated by a team of experts, including pediatric oncologists and surgeons, pediatric nurses, social workers, and psychologists.

The overall 5-year relative survival rate for childhood cancer has improved markedly over the past 3 decades, from 58.1% for cases diagnosed from 1975 to 1977 to 82.5% for diagnoses during 2001 to 2007, due to new and

improved treatments. However, rates vary considerably depending on cancer type, patient age, and other characteristics. The 5-year survival rate for retinoblastoma is 97.5%; it is 95.4% for HL, 88.4% for Wilms tumor, 85.7% for NHL, 83.1% for leukemia, 74.2% for neuroblastoma, 70.8% for brain and other nervous system tumors, 70.4% for osteosarcoma, and, 68.1% for rhabdomyosarcoma.

Common Concerns of Childhood Cancer Survivors

Children diagnosed with cancer may experience treatment-related side effects not only during treatment, but many years after diagnosis as well. Aggressive treatments used for childhood cancers during the 1970s and 1980s, resulted in a number of late effects, including an increased risk of second cancers.

Growing evidence suggests that these treatments, and even some of the newer, less toxic, therapies, may increase the risk of other serious health conditions in long-term childhood cancer survivors.²⁵ Late treatment effects can include impairment in the function of specific organs, cognitive impairments, and secondary cancers.

The most common types of second cancers occurring among childhood cancer survivors are female breast, brain/central nervous system, bone, thyroid, soft tissue, melanoma, and acute myeloid leukemia.²⁶ The Children's Oncology Group has developed long-term follow-up guidelines for the screening and management of late effects in survivors of childhood cancer. For more information on childhood cancer management, please see the Children's Oncology Group Web site (available at: survivorshipguidelines.org). The Childhood Cancer Survivor Study, which continues to follow more than 14,000 long-term survivors of childhood cancer, has also provided valuable information about the late effects of cancer treatment. For more information, visit the Childhood Cancer Survivor Study Web site (available at: ccss.stjude.org).

Common Side Effects of Treatment

Cancers occurring in adolescents (those aged 15-19 years) and young adults (those aged 20-39 years) are associated with a unique set of issues. Many types of childhood cancer are rarely diagnosed after age 15 years, while others, such as Ewing sarcoma and osteosarcoma, most commonly present during adolescence. Adolescents and young adults (AYAs) diagnosed with childhood cancers are usually most appropriately treated at pediatric facilities or by pediatric specialists rather than by adult-care specialists. Studies have shown that for young adult patients diagnosed with acute lymphocytic leukemia (ALL), outcomes are improved on pediatric, as opposed to adult, protocols.^{27,28} For AYAs diagnosed with cancers more common among adults, such as breast and colorectal cancers, treatment by adult-care specialists is more appropriate.²⁹

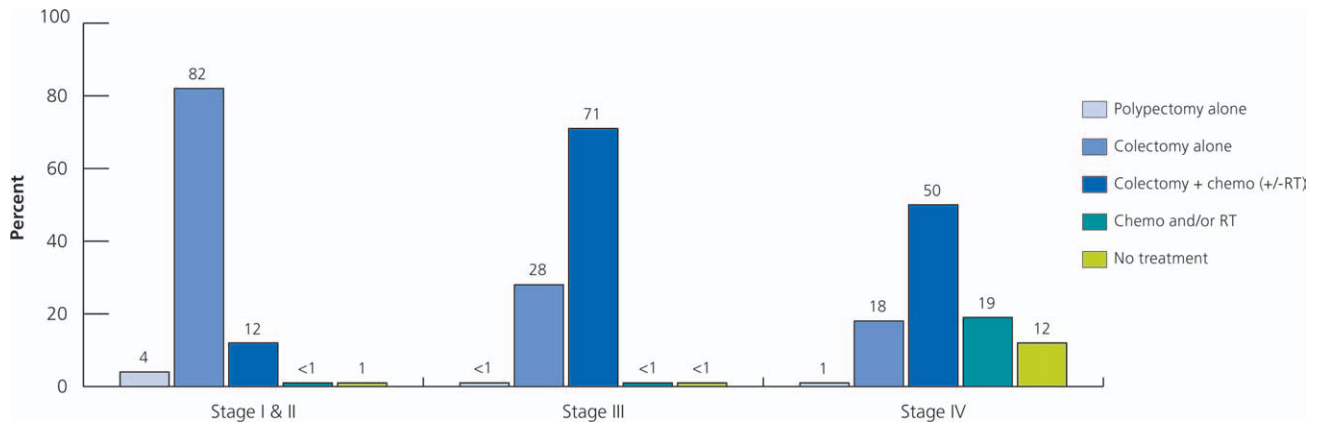


FIGURE 4. Colon Cancer Treatment Patterns by Stage, 2008.

Chemo indicates chemotherapy (may include common targeted therapies); +/-, with or without; RT, radiation therapy. Percentages do not sum to 100% due to rounding.

Data source: NCDB.

Studies have found that improvements in survival among AYAs have lagged behind those in children and even behind those for older adult patients³⁰; however, the current 5-year overall relative survival rate for AYAs is the same as that for children.⁷ Although AYAs and their families have unique stresses and concerns related to cancer, there is scant information on survivorship concerns for this group in the literature. Childhood cancer survivors and newly diagnosed AYA cancer patients often face additional challenges related to insurance coverage beginning at age 18 years. Medicaid covers cancer treatment for pediatric cancer patients who meet income criteria, but the more generous coverage lapses at age 18 or 21 years, depending on state of residence.

Colon and Rectum

It is estimated that there are nearly 1.2 million men and women living in the United States with a previous diagnosis of colorectal cancer, and an additional 143,460 will be diagnosed in 2012. The median age at diagnosis of colorectal cancer is 68 years for males and 72 years for females.⁶

Use of recommended colorectal cancer screening tests can both detect cancer earlier and prevent colorectal cancer by promoting the removal of precancerous polyps. However, only 59.1% of men and women aged 50 years and older receive colorectal cancer screening according to guidelines.³¹ As a result, just 39% of patients are diagnosed at a local stage, when treatment is most successful.⁶

Treatment and Survival

Treatment for patients with cancers of the colon and rectum varies by tumor location and stage at diagnosis (Figs. 4 and 5). Surgery to remove the cancer and nearby lymph nodes is the most common treatment for early stage (stage I and II) colon (94%) and rectal (74%) cancer. A colectomy is more commonly used for rectal cancer (26%) than for colon cancer (7%), and is often temporary.⁹

Chemotherapy alone, or in combination with radiation therapy, is often given to patients with late-stage disease (50%-70%) before or after surgery. Three targeted monoclonal antibody therapies approved by the US Food and Drug Administration to treat patients with

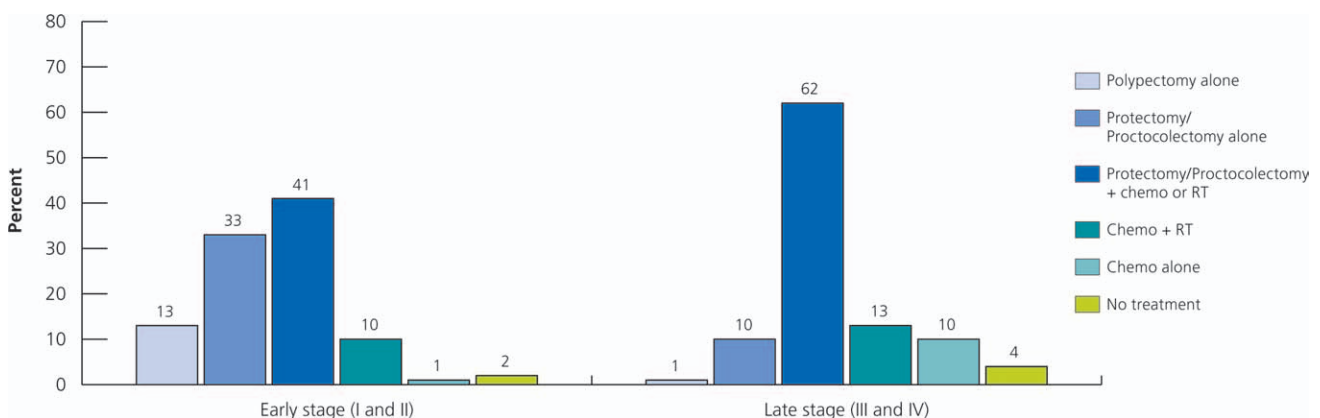


FIGURE 5. Rectal Cancer Treatment Patterns by Stage, 2008.

Chemo indicates chemotherapy (may include common targeted therapies); RT, radiation therapy. Percentages do not sum to 100% due to rounding.

Data source: NCDB.

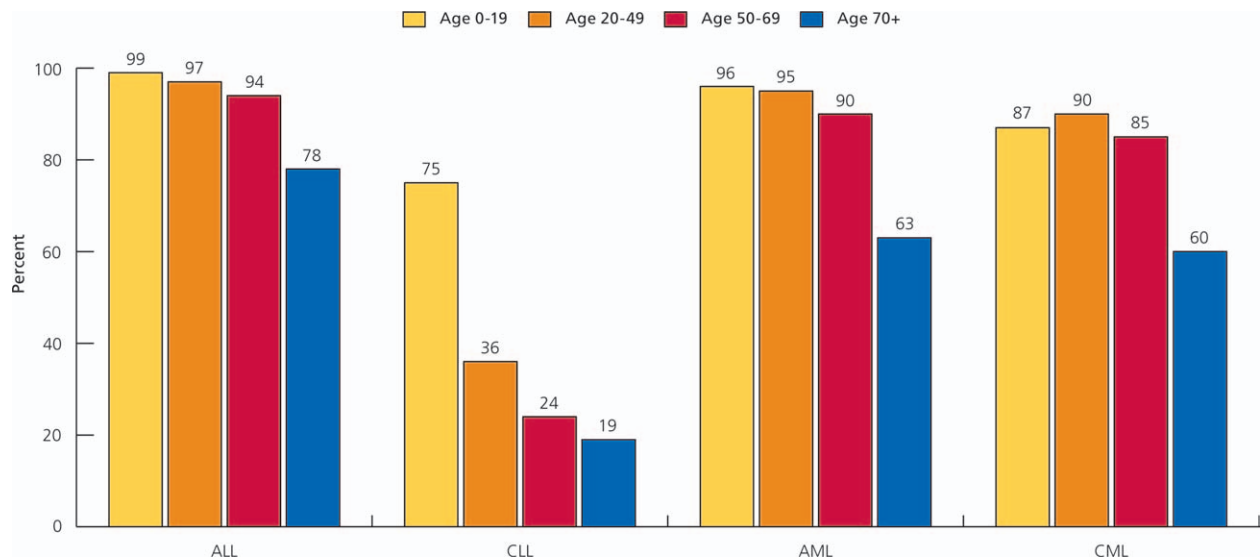


FIGURE 6. Chemotherapy Use Among Leukemia Patients by Age, 2008.

ALL indicates acute lymphocytic leukemia; CLL, chronic lymphocytic leukemia; AML, acute myeloid leukemia; CML, chronic myeloid leukemia. Note that chemotherapy may include common targeted therapies. Data source: NCDB.

metastatic colorectal cancer are bevacizumab (used by 24.2% of chemotherapy recipients in the SEER-Medicare data), cetuximab (used by 3.6% of chemotherapy recipients), and panitumumab (no data available).¹⁵

The 1-year and 5-year relative survival rates for individuals with colorectal cancer are 83.2% and 64.3%, respectively. Survival continues to decline to 57.6% at 10 years after diagnosis. When colorectal cancers are detected at a localized stage, the 5-year relative survival rate is 90.1%. After the cancer has spread regionally to involve adjacent organs or lymph nodes, the 5-year survival rate drops to 69.2%. When the disease has spread to distant organs, the 5-year survival rate is 11.7%.

Common Side Effects of Treatment

Most long-term survivors of colorectal cancer report psychological quality of life comparable to that of the general population, but a somewhat lower physical quality of life.³² Bowel dysfunction is particularly common, especially among those diagnosed with late-stage cancer. Survivors with a stoma are more likely to suffer limitations in social quality of life, particularly women.³² As many as 40% of patients treated for local and locally advanced colorectal cancer will have a recurrence; survivors of colorectal cancer are also at an increased risk of second primary cancers of the colon and rectum.^{33,34}

Leukemias and Lymphomas

It is estimated that there are 298,170 leukemia survivors living in the United States, and an additional 47,150 individuals will be diagnosed with leukemia in 2012.

Almost 90% of leukemia patients are diagnosed at age 20 years and older; AML and chronic lymphocytic leukemia (CLL) are the most common types of leukemia occurring in adults. Among children and teens, ALL is most common. The median age at diagnosis is 13 years for ALL, 72 years for CLL, 67 years for AML, and 65 years for chronic myeloid leukemia (CML) (Fig. 2).⁶

There are 2 basic categories of lymphoma: HL and NHL. NHLs can be further divided into indolent and aggressive categories, each of which includes many subtypes that progress and respond differently to treatment. Prognosis and treatment depend on the stage and type of lymphoma. Although both HL and NHL occur in children and adults, the majority (65%) of HLs occur before age 50 years, whereas 83% of NHLs occur in those aged 50 years and older (Fig. 2).

Treatment and Survival for the Most Common Types of Leukemia and Lymphoma

AML. Chemotherapy is the standard treatment for AML (Fig. 6). Some patients may also undergo stem cell transplantation and some receive radiation therapy (often as part of a conditioning regimen prior to stem cell transplantation).

About 4% of AML cases occur in children aged 14 years and younger, for whom the prognosis is substantially better than for adults. Survival for AML decreases markedly with age at diagnosis. The 5-year relative survival rate for children and adolescents (aged birth to 19 years) is 60.4%, but for patients aged 20 years to 49 years, 50 years to 64 years, and 65 years and older, it declines to 48.0%, 24.2%, and 5.2%, respectively.⁷

CML. CML is the most common leukemia diagnosed in adults, though 3% of cases are diagnosed in children.⁷ In large part due to the discovery and widespread use of BCR-ABL tyrosine kinase inhibitors, the 5-year survival rate for CML increased from 31.0% for patients diagnosed from 1990 to 1992 to 55.2% for those diagnosed from 2001 to 2007.

ALL. Although ALL is the most common type of leukemia diagnosed in children, accounting for 78% of all childhood (aged birth to 14 years) leukemia cases,⁶ 40% of cases are diagnosed in patients aged 20 years and older.⁷ Molecular subgroups differ based on age at onset.³⁵ More than 95% of children with ALL attain remission.^{36,37} Pediatric patients with ALL (aged birth to 17 years) who survive 5 years or longer have a 5-fold increased risk of a second primary malignancy compared with the general population, while adult-onset disease confers no excess risk.³³

Survival rates for patients with ALL have increased significantly over the past 3 decades for patients of all ages except those aged 65 years and older. However, 5-year relative survival rates remain substantially lower for adults (33.0% for those aged 20-49 years, 19.5% for those aged 50-64 years, and 7.3% for those aged 65 years and older) compared with children and adolescents (78.4% for those aged birth to 19 years).⁷

One of the most serious potential long-term side effects of ALL therapy in children is the development of AML, which occurs in about 5% of patients who receive epipodophyllotoxins (eg, etoposide or teniposide) or alkylating agents (eg, cyclophosphamide or chlorambucil).³⁸

CLL. CLL is the most common type of leukemia in adults; 95% of cases are diagnosed in individuals aged 50 years and older (Fig. 2). Treatment is not likely to cure CLL and is often unnecessary for patients with uncomplicated early disease for whom active surveillance is a common treatment approach. It should be noted that the low rates of chemotherapy shown for CLL in Figure 6 are for first course of treatment only and do not reflect those patients who receive chemotherapy later in the course of disease. For patients with more advanced disease, available treatments include chemotherapy, immunotherapy, radiation therapy, and splenectomy. The overall 5-year relative survival rate for CLL is 78%; however, there is a large variation in survival among individual patients, ranging from several months to a normal life expectancy.

HL. It is estimated that there are 188,590 men and women living in the US with a history of HL, with 9060 new cases expected in 2012. HL can be diagnosed at any age, but is most common in early adulthood (61% of cases are diagnosed between ages 15 years-49 years) (Fig. 2).⁶ There are 2 major types of HL. Classical HL (CHL) is the most common and is characterized by the presence of Reed-Sternberg cells. Nodular lymphocyte-predominant

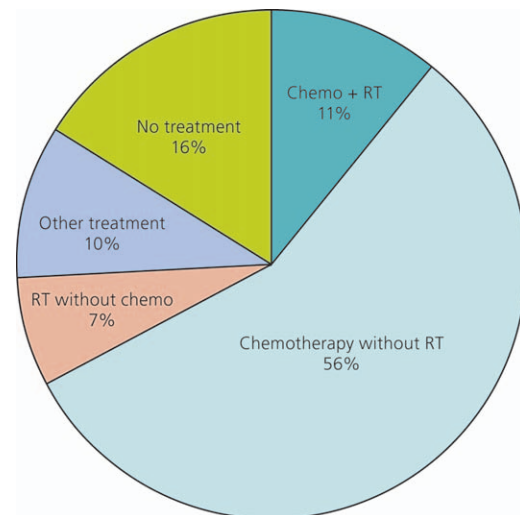


FIGURE 7. Non-Hodgkin Lymphoma Treatment Patterns, 2008.

Chemo indicates chemotherapy (may include common targeted therapies); RT, radiation therapy.
Data source: NCDB.

HL (NLPHL) is rare, representing only about 3% to 5% of cases, and is a more indolent disease with a generally favorable prognosis.^{6,39}

CHL is usually treated with multiagent chemotherapy (87%), sometimes in combination with radiation therapy (31% among chemotherapy recipients), though the use of radiation is declining.⁹ For patients with NLPHL, radiation therapy 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 relative survival rate for all HL combined has improved from 72.0% for cases diagnosed from 1975 to 1977 to 86.3% for those diagnosed from 2001 to 2007. The current 1-year and 10-year survival rates are 91.5% and 79.0%, respectively.⁷ The overall 5-year survival rate is 96.0% for NLPHL and 82.1% for CHL.

NHL. It is estimated that there are 534,950 males and females living in the United States with a diagnosis of NHL and 70,130 new cases will be diagnosed in 2012. The most common types of NHL are diffuse large B-cell lymphoma, representing 22% of cases diagnosed in the 17 SEER areas between 2001 and 2007, and follicular lymphoma, representing 12% of cases. Diffuse large B-cell lymphomas grow quickly and are cured with treatment in about one-half of all patients. In contrast, follicular lymphomas tend to grow slowly and often do not require treatment until the patient becomes symptomatic. Some cases of follicular lymphoma transform into diffuse B-cell lymphoma.⁴⁰

The first course of treatment for all NHL subtypes combined is usually chemotherapy, either in combination with (11%) or without (56%) radiation therapy; radiation without chemotherapy (7%) is used less often (Fig. 7). Approximately 16% of patients receive no initial treatment.

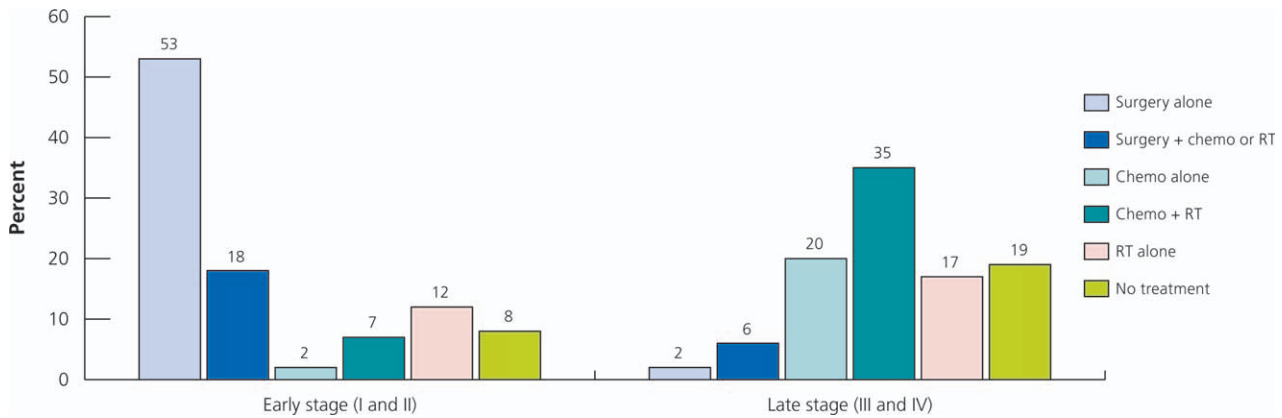


FIGURE 8. Non-Small Cell Lung Cancer Treatment Patterns by Stage, 2008.

Chemo indicates chemotherapy (may include common targeted therapies); RT, radiation therapy. Percentages do not sum to 100% due to rounding. Data source: NCDB.

The 5-year relative survival rate for all cases of NHL combined is 67.3%; by subtype, the 5-year survival rate is 84.2% for follicular lymphoma, 59.1% for diffuse large B-cell lymphoma, and 54.5% for Burkitt lymphoma.

Common Side Effects of Treatment

Children treated for leukemia and lymphoma can experience a number of significant late effects. Some children with ALL may receive cranial radiation therapy, which can cause long-term cognitive deficits. Late effects in survivors of HL include an increased breast cancer risk in women who were treated in childhood with radiation to the chest as well as various heart complications (eg, valvular heart disease and coronary artery disease).

Lung and Bronchus

It is estimated that there are 412,230 men and women living in the United States with a history of lung cancer, and an additional 226,160 cases will be diagnosed in 2012. The median age at diagnosis for lung cancer is 70 years for males and 71 years for females.⁶ The majority of lung cancers (56%) are diagnosed at a distant stage because early disease is typically asymptomatic; only 15% of cases are diagnosed at a local stage.⁶

Results from the National Lung Screening Trial, a clinical trial designed to determine the effectiveness of lung cancer screening in high-risk individuals, showed 20% fewer lung cancer deaths among current and former heavy smokers who were screened with low-dose computed tomography compared with standard chest x-ray.⁴¹ Because cancer screening tests are associated with both benefits and harms, the ACS and other organizations are now engaged in a process of carefully reviewing the evidence to determine the potential benefits and harms associated with low-dose computed tomography screening. Interim guidance for the general public and health care professionals can be found at the ACS Web site (available at: cancer.org/Healthy/FindCancerEarly/index).

Treatment and Survival

Lung cancer is classified as small cell (14% of cases) or non-small cell (85% of cases) for the purposes of treatment. Radiation therapy alone (for limited disease) or combined with chemotherapy (for extensive disease) is the standard treatment for small cell lung cancer; 70% to 90% of patients with limited disease and 60% to 70% of those with extensive disease experience at least temporary remission. For patients with early stage non-small cell lung cancer, the majority (71%) undergo surgery and approximately 18% also receive chemotherapy or radiation therapy (Fig. 8). Patients with advanced stage non-small cell lung cancer are treated with chemotherapy alone (20%), radiation therapy alone (17%), or a combination of the 2 (35%). The targeted therapy bevacizumab is used by 16.5% of chemotherapy recipients in the SEER-Medicare database¹⁵; erlotinib, cetuximab, and crizotinib may also be used to treat advanced stage disease.

The 1-year relative survival rate for lung cancer increased from 35.7% for cases diagnosed from 1975 to 1977 to 44.5% for those diagnosed from 2004 to 2007, largely due to improvements in surgical techniques and chemoradiation. The 5-year survival rate is 52.2% for cases detected when the disease is still localized, 24.3% for patients with regional disease, and 3.6% for patients with distant stage disease. The overall 5-year survival rate for small cell lung cancer (6.1%) is lower than that for non-small cell lung cancer (17.1%).

Common Side Effects of Treatment

Many lung cancer survivors have impaired lung function, especially if they have had surgery. Lung cancer survivors who smoke are at an increased risk of additional smoking-related cancers, especially in the head and neck and urinary tract, and should be encouraged to quit.³³ Survivors may feel stigmatized because of the connection

between smoking and lung cancer, which can be particularly difficult for lung cancer survivors who never smoked.⁴²

Melanoma

It is estimated that there are nearly 1 million melanoma survivors living in the United States, and an additional 76,250 individuals will be diagnosed in 2012. Melanoma incidence rates have been increasing for at least 30 years.

More than 3 out of 4 melanomas are diagnosed at a localized stage, when they are highly curable. The median age at diagnosis for melanoma is 63 years for males and 56 years for females.⁶ Although melanoma is rare before age 30 years, it is the second and third most commonly diagnosed cancer in women and men, respectively, for those ages 20 years to 29 years.

Treatment and Survival

Among patients diagnosed with malignant melanoma in SEER registries, wide-excision surgery is the primary treatment for 31% of patients with stage I disease, 46% of patients with stage II disease, 53% of patients with stage III disease, and 9% of patients with stage IV disease. Less than 3% of all patients with melanoma undergo radiation therapy. However, almost one-half (45%) of patients with advanced stage disease who receive either chemotherapy or immunotherapy also receive radiation therapy.⁹

The 5-year and 10-year relative survival rates for patients with melanoma are 91.2% and 89.1%, respectively.⁷ For those with localized melanoma, the 5-year survival rate is 98.2%; 5-year survival rates for individuals with regional and distant stage disease are 61.7% and 15.2%, respectively.

Common Side Effects of Treatment

Melanoma survivors are nearly 9 times more likely than the general population to develop additional melanomas due to genetic risk factors and/or overexposure to ultraviolet radiation.⁴³

Prostate

It is estimated that there are nearly 2.8 million men living with a history of prostate cancer in the United States, and an additional 241,740 cases will be diagnosed in 2012. The median age at diagnosis is 67 years (Fig. 2).⁶ Most prostate cancer patients in the United States are diagnosed by prostate-specific antigen screening, although many expert groups, including the ACS, have concluded that data are insufficient to recommend the routine use of this test.

Treatment and Survival

Treatment options vary depending on the stage and grade of the cancer, as well as patient comorbidity, age, and personal preferences. More than one-half (57%) of men aged younger than 65 years are treated with radical prostatectomy (Fig. 9). Those aged 65 years to 74 years commonly undergo radiation

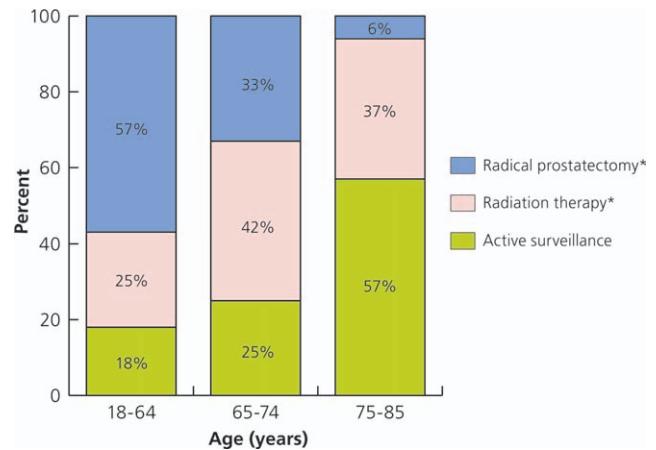


FIGURE 9. Prostate Cancer Primary Treatment Patterns by Age, 2008.

* indicates the initial treatment received.

Data source: NCDB.

therapy (42%), although radical prostatectomy (33%) is also often used. Data show similar survival rates for patients with early stage disease who are treated with either of these methods. Active surveillance rather than immediate treatment is a reasonable and commonly recommended approach, especially for older men and those with less aggressive tumors and/or more serious comorbid conditions.⁴⁴⁻⁴⁶ However, according to SEER data, the use of active surveillance declined from 44% in 1994 to 34% in 2008. Androgen deprivation therapy, chemotherapy, bone-directed therapy (such as zoledronic acid or denosumab), radiation therapy, or a combination of these treatments is used to treat more advanced disease.

More than 90% of all prostate cancers are discovered in the local or regional stages, for which the 5-year relative survival rate approaches 100%. Over the past 25 years, the 5-year relative survival rate for all stages combined has increased from 68.3% to 99.9%. The 10-year and 15-year relative survival rates are 97.8% and 91.4%, respectively.

Common Side Effects of Treatment

Many prostate cancer survivors who have been treated with surgery or radiation therapy experience incontinence, erectile dysfunction, and bowel complications. Patients receiving hormonal treatment may experience loss of libido; menopausal-like symptoms including hot flashes, night sweats, and irritability (which are often short term and treatable); and osteoporosis. In the long term, hormone therapy also increases the risk of diabetes, cardiovascular disease, and obesity.⁴⁷

Testis

It is estimated that there are 230,910 survivors of testicular cancer in the United States, and an additional 8590 men will be diagnosed in 2012. Testicular germ cell tumors (TGCTs) account for approximately 95% of all testicular cancers.⁴⁸ There are 2 main types of TGCTs: seminomas and nonseminomas. Nonseminomas generally occur in

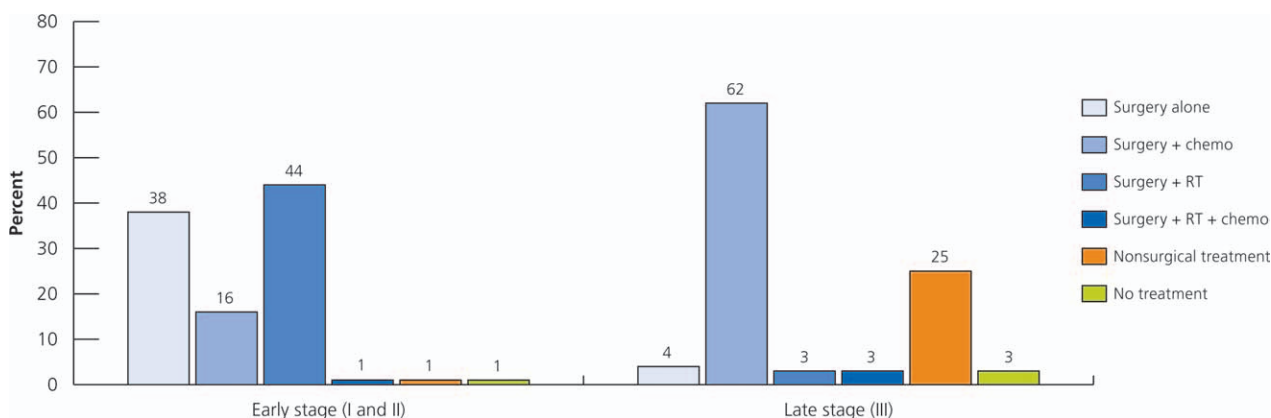


FIGURE 10. Treatment Patterns for Seminomatous Testicular Germ Cell Tumors, 2008. Chemo indicates chemotherapy (may include common targeted therapies); RT, radiation therapy. Percentages do not sum to 100% due to rounding. Data source: NCDB.

younger men (aged in their late teens to early 40s), and tend to be more aggressive. Seminomas are slow-growing and are generally diagnosed in men aged in their late 30s to early 50s. Most testicular cancers are detected early; 70% of patients are diagnosed at a localized stage.⁶

Treatment and Survival

The treatment of almost all TGCTs begins with orchiectomy. After orchiectomy, early stage seminomas are often treated with radiation (45%), whereas late-stage seminomas are generally treated with chemotherapy (65%) (Fig. 10). Men with nonseminomas are often treated with chemotherapy in addition to orchiectomy, especially at later stages of disease (Fig. 11). Among patients with early stage nonseminomas, approximately 21% undergo retroperitoneal lymph node dissection, which is recommended to reduce the likelihood of recurrence.

For all testicular cancers combined, the 5-year relative survival rates are 99.0%, 96.2%, and 72.0% for tumors diagnosed at a localized, regional, or distant stage, respectively.

Common Side Effects of Treatment

Survivors of testicular cancer are often concerned about sexual and reproductive impairments after treatment. 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 prior to treatment.

Thyroid

It is estimated that there are 558,260 people living with thyroid cancer in the United States, and an additional 56,460 will be diagnosed in 2012. The incidence rate of thyroid cancer has been increasing sharply since the mid-1990s, and it is the fastest-increasing cancer in both men and women. Some studies suggest that the rise is due to the increased detection of small tumors through ultrasound and confirmation via fine-needle aspiration,^{49,50} while others argue that it is in part real, and involves both small and large tumors.⁵¹⁻⁵³ Thyroid cancer commonly occurs at a younger age than most other adult cancers; the median age at diagnosis is

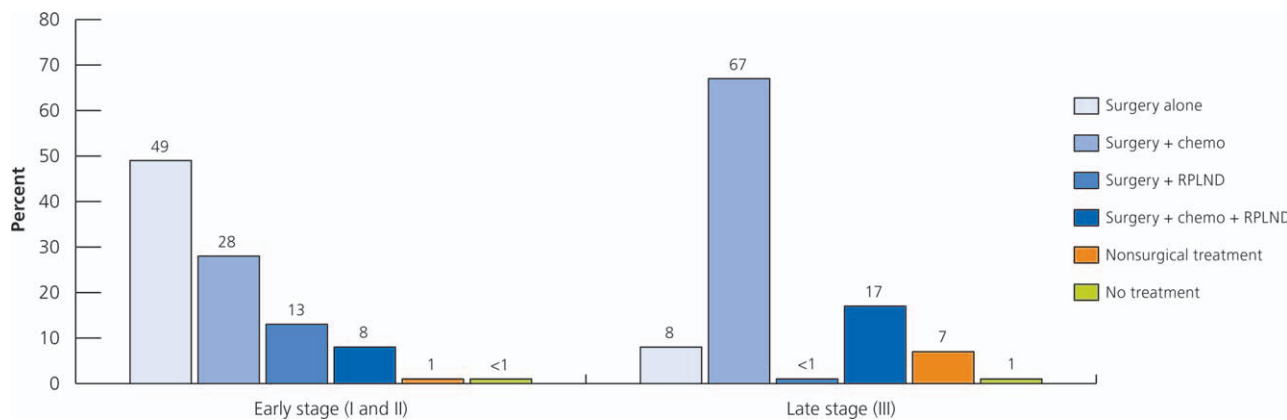


FIGURE 11. Treatment Patterns for Nonseminomatous Testicular Germ Cell Tumors, 2008. Chemo indicates chemotherapy (may include common targeted therapies); RPLND, retroperitoneal lymph node dissection. Percentages do not sum to 100% due to rounding. Data source: NCDB.

54 years for males and 48 years for females.⁶ Localized stage disease is diagnosed in 58% of male patients and 71% of female patients.

Treatment and Survival

Most thyroid cancers are either papillary or follicular carcinomas, both of which are slow-growing and highly curable. The 5% of thyroid cancers that are medullary or anaplastic are more difficult to treat because they grow more quickly and have often metastasized by the time of diagnosis. The first choice of treatment in nearly all cases is surgery, with most patients receiving total (84%) or partial (15%) thyroidectomy.⁹ Approximately 56% of surgically treated patients with well-differentiated thyroid cancer receive radioactive iodine after surgery to destroy any remaining thyroid tissue.⁵⁴ Thyroid hormone therapy is given to inhibit pituitary production of thyroid-stimulating hormone, thereby decreasing the likelihood of recurrence.

The 5-year relative survival rate for all patients with thyroid cancer is 97.3%. However, survival varies by stage and patient age at diagnosis. The 5-year survival rate is 99.8%, 96.8%, and 55.4% for localized, regional, and distant stage disease, respectively. For all stages combined, survival declines with age; rates are 99.5% for patients aged 45 years and younger and 82.2% for those aged 75 years and older.

Common Side Effects of Treatment

Patients receiving a thyroidectomy require thyroid hormone replacement (levothyroxine) and regular follow-up to achieve proper hormone blood levels.

Urinary Bladder

It is estimated that there are 585,390 urinary bladder cancer survivors living in the United States, and an additional 73,510 cases will be diagnosed in 2012. One-half of all patients with bladder cancer are diagnosed with carcinoma in situ. The median age at diagnosis is 73 years for males and 74 years for females.⁶

Treatment and Survival

Treatment of urinary bladder cancer varies by stage and patient age. For non-muscle-invasive cancers, most patients are diagnosed and treated with transurethral resection of the bladder tumor, which may be followed by chemotherapy (17%) or intravesical biological therapy with bacillus Calmette-Guerin solution (29%).⁹ (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.)

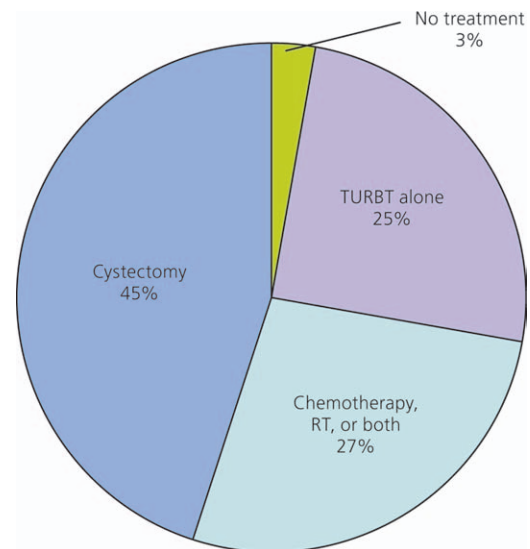


FIGURE 12. Muscle-Invasive Bladder Cancer Treatment Patterns, 2008.

TURBT indicates transurethral resection of the bladder tumor; RT, radiation therapy; cystectomy, surgery that removes all or part of the bladder as well as the surrounding fatty tissue and lymph nodes. Chemotherapy may include common targeted therapies.

Data source: NCDB.

Among patients with muscle-invasive disease, 4% undergo partial and 41% undergo total cystectomy (Fig. 12). Approximately 27% of patients received a combination of chemotherapy and high-dose radiation therapy without surgery. In appropriately selected patients, this bladder-sparing approach is as effective as cystectomy at preventing recurrence.⁵⁵ For advanced cancers that have not spread to other organs, patients may be offered chemotherapy alone (26%) or in combination with radiation therapy (11%) in an effort to shrink the tumor and permit cystectomy.⁹

For all disease stages combined, the 5-year relative survival rate is 78.1%. Survival declines to 71.4% at 10 years and 65.4% at 15 years after diagnosis. When in situ urinary bladder cancer is diagnosed, the 5-year survival rate is 96.6%. Patients with invasive tumors diagnosed at a localized stage have a 5-year survival rate of 70.7%; approximately 35% of cancers are detected at this early stage. For those with regional and distant disease, the 5-year survival rate is 34.6% and 5.4%, respectively.

Common Side Effects of Treatment

The high rate of bladder cancer recurrence (range, 50%–90%) necessitates active bladder cancer surveillance among survivors.^{56,57} Patients undergoing cystectomy require urinary diversion with either the construction of a neobladder with urethral anastomosis (20%) or a urostomy (80%).⁵⁸ While urostomy patients may experience urinary leakage, decreased sexual function, and psychosocial issues related to body image, neobladder patients report significantly lower urinary function scores than urostomy patients.⁵⁹

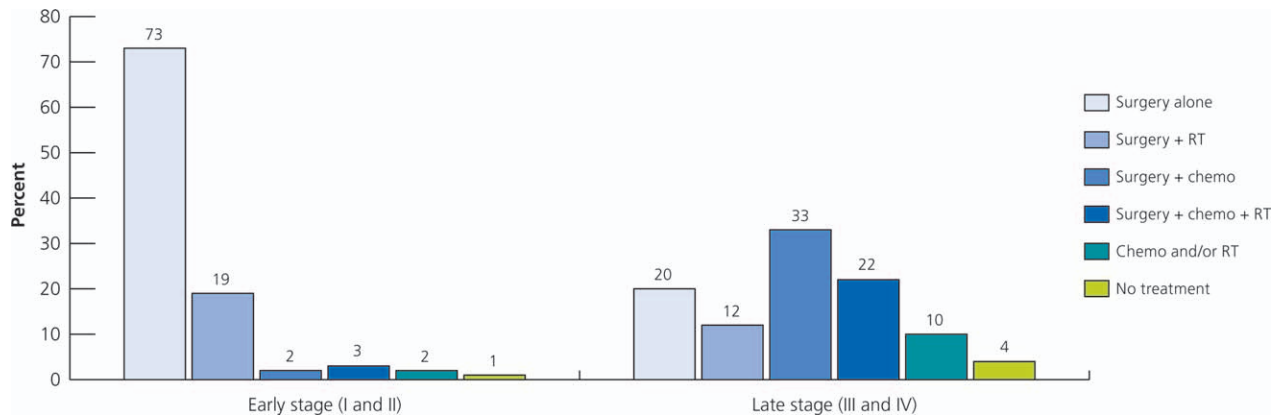


FIGURE 13. Uterine Cancer Treatment Patterns by Stage, 2008.

RT indicates radiation therapy; chemo, chemotherapy (may include common targeted therapies). Percentages do not sum to 100% due to rounding. Data source: NCDB.

Uterine Corpus

There are an estimated 606,910 women living in the United States with a previous diagnosis of cancer of the uterus and corpus, NOS (uterus) and an additional 47,130 cases will be diagnosed in 2012. Uterine cancer is the second most prevalent cancer among women, following breast cancer. More than 90% of these cancers develop in the endometrium. Most cancers of the uterine corpus (68%) are diagnosed at an early stage, usually because of postmenopausal bleeding. The median age at diagnosis for cancer of the uterine corpus is 61 years (Fig. 2).⁶

Treatment and Survival

Cancers of the uterine corpus are usually treated with surgery, radiation therapy, hormone therapy, and/or chemotherapy, depending on the stage of disease (Fig. 13). Surgery alone, consisting of hysterectomy (often along with bilateral salpingo-oophorectomy), is used to treat 73% of patients with early stage disease. About 22% of all patients have higher risk early stage disease and receive radiation therapy, either alone or in combination with chemotherapy, in addition to surgery.⁹ The majority (67%) of women with advanced disease receive surgery followed by radiation and/or chemotherapy.

The 1-year, 5-year, and 10-year relative survival rates for cancer of the uterine corpus are 92.0%, 81.8%, and 79.5%, respectively. The 5-year survival rate is 95.8% for localized disease, 67.0% for regional disease, and 15.9% distant stage disease.

Common Side Effects of Treatment

Any hysterectomy causes infertility. Bilateral oophorectomy will cause menopause in premenopausal women, which can lead to symptoms such as hot flashes, night sweats, and vaginal dryness. Sexual problems are commonly reported among uterine cancer survivors.

Pelvic lymphadenectomy can lead to lymphedema of the lower extremities, particularly for women who receive radiation therapy.

Common Effects of Cancer and Its Treatment

The management of symptoms related to cancer and toxicities from its treatment are an important part of cancer care, affecting the completion of treatment and both short-term and long-term quality of life and physical and psychological functioning. The vast majority of cancer patients experience one or more symptoms or side effects during active treatment,⁶⁰ with the most commonly reported symptoms being pain, fatigue, and emotional distress.⁶¹ Late effects may surface months or even years after treatment has ended.

Bone Density

Many cancer therapies cause a reduction in bone density.⁶² Osteopenia and osteoporosis are common side effects in breast cancer patients with chemotherapy-induced ovarian failure and those treated with aromatase inhibitors.⁶³ Osteoporosis increases the risk of fractures, which are associated with a reduced quality of life, particularly among older survivors.⁶⁴ A prospective study of more than 5000 breast cancer survivors found a 15% increased risk of fractures within 5 years of diagnosis compared with women with no history of cancer.⁵² Prostate cancer patients who are treated with bilateral orchiectomy or androgen ablation therapy experience significant bone loss as early as 1 year posttreatment.⁶⁵⁻⁶⁸ A large study of patients with prostate cancer surviving at least 5 years after diagnosis found that 19.4% of men treated with androgen deprivation therapy experienced a fracture, compared with 12.6% of men who did not receive this treatment.⁶⁹ The skeleton is also one of the most common sites of cancer metastasis. Among those with advanced disease, 73% of breast cancer patients and 68% of prostate cancer patients develop bone metastases.⁶²

Cardiotoxicity

Cancer treatment can cause a wide range of cardiovascular diseases.⁷⁰ A number of cytotoxic drugs, particularly anthracyclines (eg, doxorubicin) but also cyclophosphamide, cisplatin, fluorouracil, and taxanes, can result in cardiomyopathy, ischemia, and dysrhythmias.⁷¹ Chronic anthracycline cardiomyopathy may occur years after the completion of treatment.⁷² When trastuzumab is combined with anthracyclines, the risk of cardiac toxicity appears to increase.⁷³⁻⁷⁵ Cardiovascular toxicity from radiotherapy can present in a number of ways, including as accelerated atherosclerosis of coronary arteries in the irradiated areas, dysrhythmia, and valvular disease.⁷⁶⁻⁷⁸ A large, long-term study of excess cardiovascular mortality in survivors of childhood cancer reported a 4-fold increased risk for chemotherapy recipients and a 5-fold increased risk for patients treated with radiotherapy, with a linear dose-response observed for radiation to the heart.⁷⁹

Cognitive Deficits

Cognitive deficits from cancer treatment, often referred to as “chemo brain,” may include problems with attention, concentration, memory, and mental processing speed. Although only a subgroup of survivors suffer long-term cognitive dysfunction, these deficits can be debilitating.^{80,81} Long-term survivors of breast, lung, and ovarian cancers and lymphoma may have cognitive⁸²⁻⁸⁷ and neurological⁸⁸ complications caused by systemic chemotherapy. The study of brain dysfunction in these patients is complicated by chemotherapy-related fatigue, depression, and anxiety, which can also contribute to poor cognitive performance.⁸⁹ The risk of cognitive impairment from chemotherapy increases with advanced age, lower pretreatment intelligence quotient, and the apolipoprotein E genotype, which is associated with Alzheimer disease.⁸²

Distress

Cancer-related distress has been defined as a multifactorial, unpleasant emotional experience of a psychosocial nature that may interfere with the ability to cope effectively with cancer and its treatment.⁹⁰ Distress in cancer patients may be difficult to identify because the signs often overlap with the symptoms of disease and treatment (eg, fatigue, changes in appetite, and sleep disruptions). Almost all cancer patients experience some level of distress, ranging from mild, which may be addressed by discussions with the treatment team, to more severe, which should be referred to appropriate supportive services (mental health, social work, and counseling). A recent meta-analysis found that 30% to 40% of cancer patients had diagnosable mood disorders.⁹¹ The early detection and treatment of distress can improve treatment adherence and patient-provider communication and decrease the risk of severe depression or anxiety.⁹⁰

Fatigue

Fatigue is the most common side effect of active cancer treatment, reported in 28% to 90% of cancer patients depending upon the study and 80% to 90% of those receiving chemotherapy or radiation.⁹² Compared with fatigue experienced by healthy individuals, cancer-related fatigue is more severe, more distressing, and less likely to be relieved with rest. For many patients, chronic fatigue persists long after treatment has ended. Studies have found that cancer-related fatigue is commonly associated with sleep disturbance, emotional distress, and pain.⁹³ Cancer patients may experience fatigue due to anemia, which can be treated with a variety of medications or blood transfusion. However, cancer-related fatigue is not fully explained by anemia.⁹⁴ Causes of cancer-related fatigue are multifactorial,^{95,96} and may include depression,^{97,98} chronic inflammatory processes with elevated cytokines,⁹⁹⁻¹⁰¹ and alterations in muscular energy systems activity.⁹⁵ Prevalence estimates for cancer-related fatigue among survivors vary for a number of reasons, including case-mix, lack of a consensus definition of fatigue, and the use of different assessment tools.¹⁰² However, using specific diagnostic criteria established for a clinical syndrome of cancer-related fatigue, at least 3 studies have suggested that persistent fatigue is present in 17% to 26% of cancer survivors.^{94,103,104} HL survivors,^{101,105} breast cancer survivors treated with adjuvant chemotherapy,^{99,106-108} ovarian cancer survivors,¹⁰⁹ and bone marrow transplant recipients^{101,110} appear to be particularly susceptible. A variety of interventions are recommended for cancer patients experiencing fatigue.⁹³ Meta-analyses show that exercise, especially moderate-intensity resistance exercise, reduces cancer-related fatigue,¹¹¹ and provide preliminary evidence of the efficacy of psychological interventions¹¹² or psychostimulants.¹¹³

Fear of Cancer Recurrence

Fear of cancer recurrence is among the chief concerns of posttreatment cancer survivors and may persist long after treatment ends, even among survivors who are considered to be cancer free or in remission.¹¹⁴⁻¹¹⁸ For example, data from the ACS Studies of Cancer Survivors indicate that nearly 60% of 1-year cancer survivors reported moderate to severe concerns about disease recurrence.¹¹⁹ Fear of recurrence is elevated among survivors and their caregivers who find less meaning in the cancer experience and who experience more concomitant family stressors.¹²⁰

Infertility

Infertility can result from surgery, radiation therapy, or chemotherapy.¹²¹ Alkylating agent-based chemotherapy has a highly toxic effect on the ovaries that increases with dose and duration. Outcomes in premenopausal women

include preservation of menses, temporary amenorrhea, or early-onset menopause. Risk of ovarian failure is highest among women closest to natural menopause, who have smaller follicular reserves.¹²² Uterine radiation is associated with infertility, miscarriage, preterm labor, and low-birthweight infants.¹²³ Male infertility from cancer surgery or radiation therapy can result from anatomic changes, hormonal imbalances, or lower production and quality of sperm.^{124,125}

Pain

A recent meta-analysis estimated the prevalence of pain to be 59% among patients in active treatment, 33% among survivors after treatment, and 64% among those with advanced/metastatic/terminal disease.¹²⁶ Cancer-related pain reduces quality of life and is associated with depression and poor functioning.¹²⁷ Although studies suggest that pain control can be achieved for 80% of cancer patients experiencing pain, it is frequently underassessed, underreported, and undertreated.¹²⁶ Both surgery and radiation therapy can cause nerve damage, resulting in chronic pain. Chemotherapy drugs, especially vincristine and the taxanes, can damage sensory nerve cells, causing peripheral neuropathy.¹²⁸ The extent of damage is dose-dependent and may take months or years to resolve. Clinical practice guidelines from both the World Health Organization and the National Comprehensive Cancer Network recommend pain assessment throughout the course of treatment and continuing care.^{129,130}

Pulmonary Dysfunction

Surgery for lung cancer is usually associated with dyspnea and reduced lung functioning. In addition, alkylating agents and radiation therapy cause pulmonary fibrosis that may progress asymptotically for years after treatment.^{131,132}

Sexual Dysfunction

Although sexual dysfunction is typically associated with males treated for prostate cancer,^{133,134} a large percentage of female survivors of gynecologic and breast cancers also experience sexual dysfunction.^{135,136} After the completion of treatment, 20% to 30% of breast cancer survivors¹³⁷ and nearly 80% of prostate cancer survivors¹³⁸ report sexual difficulties. In female survivors, painful sex is the most prevalent symptom, while the most common symptom for men is erectile dysfunction. For both sexes, a diminished interest in sex is frequently reported and is often persistent.¹³⁹ Factors causing or contributing to sexual dysfunction include physical changes related to cancer treatment (eg, damage from radiation treatments, nerve damage from prostatectomy), hormonal changes (eg, androgen-suppressing treatments for prostate cancer or ovarian failure), negative body image, and cancer-related fatigue.

Palliative Care

Palliative care plays an important role in quality cancer care throughout active treatment and survivorship. The goal of palliative care is to provide comprehensive relief from disease- and treatment-related symptoms in order to achieve the highest possible quality of life. Palliative care can be administered along with curative treatment, and offers patients and families more choice to ensure that treatment and symptom control are aligned with individual goals and preferences. Engaging all members of the health care team reduces communication barriers to optimal symptom management. Palliative care has been consistently shown to improve quality of life by addressing the harmful effects of pain, other physical symptoms, and emotional distress. It can also function to reduce the family caregiver burden.¹⁴⁰

In response to the increasing number and needs of Americans living with serious, complex, and chronic illnesses like cancer, the number of palliative care teams in hospitals has more than doubled within the past 5 years.¹⁴¹ Currently, there are about 1500 hospitals providing palliative care services nationwide; nevertheless, millions of Americans still do not have access to palliative care services, with considerable variation in availability from state to state.^{141,142}

The Recovery Phase

Regular medical care following primary treatment is particularly important for cancer survivors because of the potential persistent and delayed effects of treatment, as well as the risk of recurrence and additional primary malignancies. In 2006, the Institute of Medicine (IOM) Committee on Cancer Survivorship published a report highlighting the need for a strategy to improve the coordination of ongoing care for survivors.³⁴ A follow-up report recommended that patients and their primary care providers be given a treatment summary and comprehensive survivorship care plan developed by one or more members of the oncology team. The treatment summary, which provides a foundation for the plan, contains the details of diagnosis, treatment, and complications. The survivorship care plan may include a schedule of follow-up visits, symptoms of which to be aware, potential long-term treatment effects, health behaviors to enhance recovery, and community resources.^{143,144}

Unfortunately, many survivors do not receive this information. A recent study found that less than one-half (43%) of all NCI-designated cancer centers provide survivorship care plans to their breast and colorectal cancer patients; of those that do, none include all of the IOM-recommended components.¹⁴⁵ There are numerous obstacles to the implementation of survivorship care plans, including institutional and provider commitment. The IOM recommends that the document be written by the primary

coordinator of treatment and be reimbursed by third-party payers.³⁴ The implementation of survivorship care plans could be facilitated by the development of consensus guidelines for survivor care to provide content for the plans and the use of electronic systems to reduce the time required of clinicians to individually tailor the plans.¹⁴⁶

Long-Term Survivorship

Long-term survivorship, the last phase of the cancer continuum, can be both stressful and hopeful. Survivors are relieved to have completed treatment, but may need to make physical, emotional, social, and spiritual adjustments to find a “new normal.” Please refer to Table 3 at the end of this article for information about a new resource established to improve the quality of life of cancer survivors.

Quality of Life

Quality of life is a broad multidimensional concept that considers a person’s physical, emotional, social, and spiritual well-being.¹⁴⁷ Physical well-being is the degree to which symptoms and side effects such as pain, fatigue, and poor sleep quality affect the ability to function. Emotional, or psychological, well-being refers to the ability to maintain control over anxiety, depression, fear of cancer recurrence, memory loss, and concentration difficulties. Social well-being primarily addresses relationships with family and friends, including intimacy and sexuality. Employment, insurance, and financial concerns also affect social well-being. Finally, spiritual well-being is derived from drawing meaning from the cancer experience, either within the context of religion or through maintaining hope and resilience in the face of uncertain future health.

The majority of long-term, disease-free cancer survivors (5 years or more) report a quality of life comparable to those with no history of cancer.¹⁴⁸ However, more invasive and aggressive treatment regimens tend to be associated with poorer functioning in the long term. Certain groups report greater difficulty regaining quality of life, including women; nonwhites; and those who are diagnosed at a younger age, have other chronic health conditions, have lower socioeconomic status, or are unemployed.¹⁴⁹⁻¹⁵¹

Numerous studies have found disparities in physical well-being among cancer survivors. For example, one study of breast cancer survivors found that African American race and lower socioeconomic status were associated with poorer physical functioning.¹⁵² Age is also an important predictor of quality of life; survivors diagnosed at a younger age tend to have poorer emotional functioning, whereas an older age at diagnosis is often associated with poorer physical functioning.^{153,154} Some survivors of childhood cancers have functional or cognitive impairments that impede their ability to complete their education and find employment, which in turn impacts psychological well-being and overall quality of life.¹⁵⁵

Although the negative effects of a cancer diagnosis are well-documented, there has been growing recognition that the cancer experience may result in a wide range of positive outcomes. Indeed, many survivors report a greater appreciation for life, improved relationships with family and friends, an enhanced sense of meaning and purpose, and an increased ability to cope with stress and other challenges in life as a result of the cancer experience.¹⁵⁶

Regaining and Improving Health Through Health Behaviors

Health behaviors that reduce cancer risk are particularly relevant for survivors. For example, posttreatment physical activity has been associated with increased recurrence-free and overall survival, whereas overweight and obesity have been consistently associated with an increased risk of recurrence and poorer survival for many cancers.¹⁵⁷⁻¹⁶⁰ Continued smoking after treatment also increases the risk of recurrence and of smoking-related second cancers.^{161,162}

In addition to improving cancer outcomes, healthy behaviors may also benefit survivor functioning and quality of life.¹⁶³ Clinical trials have demonstrated that exercise can improve heart and lung function and reduce cancer-related fatigue among survivors.^{164,165} The growing evidence that primary preventive health behaviors are beneficial to survivors led the ACS to develop a guide for physical activity and nutrition during and after cancer treatment, which was updated in 2012.¹⁶⁶

Physical Activity

Physical activity can hasten recovery from the immediate side effects of treatment, prevent long-term effects, and may reduce the risk of recurrence and increase survival.¹⁶⁷ In observational studies among breast cancer survivors, moderate physical activity has been associated with a reduced risk of death from all causes (24%-67%) and breast cancer (50%-53%).¹⁶⁸ Similar benefits have been observed among colon cancer survivors.¹⁶⁹ Intervention studies have shown that exercise can improve fatigue, anxiety, depression, self-esteem, happiness, and quality of life in cancer survivors.¹⁶⁴

Exercise for cancer survivors should be individualized and tailored according to the disease site and stage and the survivor’s capabilities. Barriers to engaging in physical activity may be symptomatic, physical, psychosocial, or financial.¹⁶⁹ Other barriers include a lack of awareness of exercise programs, unfavorable community environments, and work and family obligations.

Nutrition and Maintaining a Healthy Body Weight

Weight management is important for cancer survivors. During treatment, though many patients become underweight due to treatment-related side effects, some patients gain weight.¹⁷⁰ Numerous studies have shown that obesity and weight gain in breast cancer survivors is associated with

increased risk of recurrence and decreased survival; the evidence is less clear for patients with colorectal and other cancers.¹⁷¹

A diet that is plentiful in fruit, vegetables, and whole grains but contains limited amounts of fat, red and processed meat, and simple sugars may reduce both the risk of developing second cancers and the risk of chronic diseases.¹⁷² Alcohol consumption is associated with an increased risk of cancers of the mouth, pharynx, larynx, esophagus, liver, colorectum, and breast.¹⁷¹

Smoking Cessation

Smoking increases the risk of more than 15 different types of cancer and accounts for at least 30% of all cancer deaths. Smoking also interferes with some common cancer treatments. Still, a substantial number of cancer survivors continue to smoke after their diagnosis.¹⁷³ According to data from the National Health Interview Survey (2000-2008), 40% of cancer survivors aged 18 years to 44 years are current smokers, compared with 24% of the general population.¹⁷⁴ Studies have shown that smoking cessation efforts are most successful when they are initiated soon after diagnosis.¹⁷⁵

Sun Exposure

Cancer survivors, particularly those diagnosed with skin cancers, should be encouraged to adopt skin care behaviors to decrease their risk of developing skin cancer, including wearing sunscreen and protective clothing and avoiding sunbathing and artificial tanning.

Caregivers

As hospital space becomes limited to acute care and cancer treatments are delivered more frequently in outpatient care settings, tremendous responsibility increasingly rests with caregivers. One study found that even 2 years after the cancer diagnosis, caregivers were still spending an average of 8 hours a day providing care.¹⁷⁶ Over time, caregivers may become increasingly vulnerable to psychological distress, depression, and anxiety, which can be exacerbated by feelings of social isolation.¹⁷⁷ How the caregiver copes with these feelings can play a crucial role in their well-being.¹⁷⁸ Social support can help buffer the negative consequences of caregiver stress and serve to maintain, protect, or improve health. Caregivers fare better when they participate in social support programs aimed at teaching effective coping skills.

A cancer diagnosis can become a “teachable moment” for caregivers as well as survivors, wherein the illness experience becomes a catalyst for behavior changes and sustainable lifestyle benefits.¹⁷⁹ Increasing evidence has shown that caregivers may also be motivated to make positive changes to improve their health after a loved one’s

cancer diagnosis.¹⁸⁰ It is within the “teachable moment” that health behavior interventions can become ingrained habits and have the greatest potential for long-term adoption by both survivors and caregivers.

Anxiety about the future and fear of cancer recurrence are lingering issues for caregivers.¹²⁰ A higher level of fear of recurrence is experienced by caregivers of survivors diagnosed at a more advanced stage of disease or with a more aggressive cancer.¹⁸¹ Caregivers can be apprehensive as they reintegrate into life after the patient completes treatment.¹⁸² To ease this transition, caregivers may benefit from coping strategies, such as stress management or relaxation techniques.

Across the cancer trajectory, caregivers often experience persistent levels of psychological distress that are equal to or greater than those of the survivor.¹⁸³ Numerous studies have shown that female caregivers experience more care-related distress and have a higher risk of poor physical and emotional health than their male counterparts.¹⁸⁴⁻¹⁸⁶

TABLE 3. National Cancer Survivorship Resource Center

National Cancer Survivorship Resource Center

The National Cancer Survivorship Resource Center (The Survivorship Center) is a collaboration between the American Cancer Society and the George Washington Cancer Institute, funded by the Centers for Disease Control and Prevention. Its goal is to shape the future of posttreatment cancer survivorship care and to improve the quality of life of cancer survivors. The Survivorship Center staff and more than 100 volunteer survivorship experts nationwide developed the tools listed below for cancer survivors, caregivers, health care professionals (HCPs), and policy and advocacy efforts.

Tools for Cancer Survivors and Caregivers

Life After Cancer Treatment Guide. A quick, easy-to-read information guide to help cancer survivors and their caregivers understand the various aspects of the survivorship journey. The guide also includes trusted resources for survivorship information and encourages communication with HCPs. The guide is available online at cancer.org/survivorshipguide.

Survivorship Information Resource Inventory. An inventory of information resources to assist posttreatment survivors. It is available online at cancer.org/survivorshipresourceinventory.

Tools for HCPs

Prescription for Cancer Information. A tool to help HCPs talk to survivors about resources available in their office or clinic, in the community, online, and over the telephone. This tool is available online at cancer.org/survivorshipprescription.

Moving Beyond Patient Satisfaction: Tips to Measure Program Impact Guide. A brief guide detailing indicators and outcome measures that can be used to monitor the success of survivorship programs, available online at cancer.org/survivorshipprogramevaluation.

Tools for Advocates and Policy Makers

The Survivorship Center recognizes the importance of policies that support quality survivorship care. To educate policy makers on these issues, a white paper was created describing the priority areas for improving survivorship care. This paper is available online at cancer.org/survivorshippolicypaper.

To find out more about the Survivorship Center’s activities, visit cancer.org/survivorshipcenter.

Although cancer caregiving can be physically and emotionally demanding, it can also be a meaningful and satisfying experience. The phenomenon of finding good from difficult life experiences is known as benefit-finding or posttraumatic growth. A cancer diagnosis can serve as a catalyst to reprioritize life, restore personal relationships, adopt a more positive self-view, and become more empathetic toward others. Recent studies show that both survivors and their caregivers often find benefit in the challenges associated with cancer.^{187,188} Better adjustment and overall

quality of life have been attributed to such positive growth. The cancer survivor's circle of family members and friends become cosurvivors in the cancer journey. Ensuring that caregivers are healthy, both emotionally and physically, is imperative for optimal survivorship care.

Table 3 provides information regarding the new National Cancer Survivorship Resource Center, which has engaged more than 100 volunteer survivorship experts nationwide to develop tools for cancer survivors, caregivers, health care professionals, advocates, and policy makers. ■

References

- Mullan F. Seasons of survival: reflections of a physician with cancer. *N Engl J Med*. 1985;313:270-273.
- Verdecchia A, De Angelis G, Capocaccia R. Estimation and projections of cancer prevalence from cancer registry data. *Stat Med*. 2002;21:3511-3526.
- Mariotto AB, Yabroff KR, Feuer EJ, De Angelis R, Brown M. Projecting the number of patients with colorectal carcinoma by phases of care in the US: 2000-2020. *Cancer Causes Control*. 2006;17:1215-1226.
- Mariotto AB, Yabroff KR, Shao Y, Feuer EJ, Brown ML. Projections of the cost of cancer care in the United States: 2010-2020. *J Natl Cancer Inst*. 2011;103:117-128.
- Zhu L, Pickle LW, Ghosh K, et al. Predicting US- and state-level cancer counts for the current calendar year: Part II: evaluation of spatiotemporal projection methods for incidence. *Cancer*. 2012;118:1100-1109.
- Howlader N, Noone AM, Krapcho M, et al, eds. *SEER Cancer Statistics Review, 1975-2008*. Bethesda, MD: National Cancer Institute, 2011.
- Surveillance, Epidemiology, and End Results (SEER) Program. SEER*Stat Database: Incidence-SEER 17 Regs Public Use, Nov. 2010 Sub (2000-2008)-Linked to County Attributes-Total US, 1969-2008 Counties. Bethesda, MD: National Cancer Institute, Division of Cancer Control and Population Sciences, Surveillance Research Program, Cancer Statistics Branch; 2011.
- Surveillance, Epidemiology, and End Results (SEER)*Stat software. Version 7.0.5. Bethesda, MD: Statistical Research and Applications Branch, National Cancer Institute; 2011.
- American College of Surgeons Commission on Cancer. National Cancer Data Base, 2008 Data Submission. Chicago, IL: American College of Surgeons; 2011.
- Bilimoria KY, Bentrem DJ, Stewart AK, Winchester DP, Ko CY. Comparison of commission on cancer-approved and -non-approved hospitals in the United States: implications for studies that use the National Cancer Data Base. *J Clin Oncol*. 2009;27:4177-4181.
- Fedewa SA, Etzioni R, Flanders WD, Jemal A, Ward EM. Association of insurance and race/ethnicity with disease severity among men diagnosed with prostate cancer, National Cancer Database 2004-2006. *Cancer Epidemiol Biomarkers Prev*. 2010;19:2437-2444.
- Bhargava A, Du XL. Racial and socioeconomic disparities in adjuvant chemotherapy for older women with lymph node-positive, operable breast cancer. *Cancer*. 2009;115:2999-3008.
- Fedewa SA, Ward EM, Stewart AK, Edge SB. Delays in adjuvant chemotherapy treatment among patients with breast cancer are more likely in African American and Hispanic populations: a national cohort study 2004-2006. *J Clin Oncol*. 2010;28:4135-4141.
- Potosky AL, Riley GF, Lubitz JD, Mentech RM, Kessler LG. Potential for cancer related health services research using a linked Medicare-tumor registry database. *Med Care*. 1993;31:732-748.
- Surveillance, Epidemiology, and End Results Program. SEER-Medicare Data (2004-2006). Bethesda, MD: National Cancer Institute, Division of Cancer Control and Population Sciences, Applied Research Program, Health Services and Economics Branch; 2010.
- Jatoi I, Proschan MA. Randomized trials of breast-conserving therapy versus mastectomy for primary breast cancer: a pooled analysis of updated results. *Am J Clin Oncol*. 2005;28:289-294.
- Alderman AK, Hawley ST, Waljee J, Morrow M, Katz SJ. Correlates of referral practices of general surgeons to plastic surgeons for mastectomy reconstruction. *Cancer*. 2007;109:1715-1720.
- Alderman AK, Wei Y, Birkmeyer JD. Use of breast reconstruction after mastectomy following the Women's Health and Cancer Rights Act. *JAMA*. 2006;295:387-388.
- Christian CK, Niland J, Edge SB, et al. A multi-institutional analysis of the socioeconomic determinants of breast reconstruction: a study of the National Comprehensive Cancer Network. *Ann Surg*. 2006;243:241-249.
- Lee CN, Belkora J, Chang Y, Moy B, Partridge A, Sepucha K. Are patients making high-quality decisions about breast reconstruction after mastectomy? [outcomes article]. *Plast Reconstr Surg*. 2011;127:18-26.
- Tseng JF, Kronowitz SJ, Sun CC, et al. The effect of ethnicity on immediate reconstruction rates after mastectomy for breast cancer. *Cancer*. 2004;101:1514-1523.
- Berry DA, Cronin KA, Plevritis SK, et al. Effect of screening and adjuvant therapy on mortality from breast cancer. *N Engl J Med*. 2005;353:1784-1792.
- Petrek JA, Senie RT, Peters M, Rosen PP. Lymphedema in a cohort of breast carcinoma survivors 20 years after diagnosis. *Cancer*. 2001;92:1368-1377.
- Lawenda BD, Mondry TE, Johnstone PA. Lymphedema: a primer on the identification and management of a chronic condition in oncologic treatment. *CA Cancer J Clin*. 2009;59:8-24.
- Oeffinger KC, Mertens AC, Sklar CA, et al. Chronic health conditions in adult survivors of childhood cancer. *N Engl J Med*. 2006;355:1572-1582.
- Inskip PD, Curtis RE. New malignancies following childhood cancer in the United States, 1973-2002. *Int J Cancer*. 2007;121:2233-2240.
- Boissel N, Auclerc MF, Lheritier V, et al. Should adolescents with acute lymphoblastic leukemia be treated as old children or young adults? Comparison of the French FRALLE-93 and LALA-94 trials. *J Clin Oncol*. 2003;21:774-780.
- Hallbook H, Gustafsson G, Smedmyr B, Soderhall S, Heyman M; Swedish Adult Acute Lymphocytic Leukemia Group; Swedish Childhood Leukemia Group. Treatment outcome in young adults and children > 10 years of age with acute lymphoblastic leukemia in Sweden: a comparison between a pediatric protocol and an adult protocol. *Cancer*. 2006;107:1551-1561.
- Bleyer A. Young adult oncology: the patients and their survival challenges. *CA Cancer J Clin*. 2007;57:242-255.
- Bleyer A, O'Leary M, Barr R, Ries LAG. Cancer Epidemiology in Older Adolescents and Young Adults 15 to 29 Years of Age, Including SEER Incidence and Survival: 1975-2000. NIH Pub. No. 06-5767. Bethesda, MD: National Cancer Institute; 2006.
- American Cancer Society. Cancer Prevention & Early Detection Facts & Figures 2012. Atlanta, GA: American Cancer Society; 2012.
- Jansen L, Koch L, Brenner H, Arndt V. Quality of life among long-term (≥ 5 years) colorectal cancer survivors—systematic review. *Eur J Cancer*. 2010;46:2879-2888.
- Curtis RE, Freedman DM, Ron E, et al. New Malignancies Among Cancer Survivors: SEER Cancer Registries, 1973-2000. NIH Pub. No. 05-5302, Bethesda, MD: National Cancer Institute; 2006.
- Institute of Medicine. From Cancer Patient to Cancer Survivor: Lost in Transition. Washington, DC: The National Academies Press; 2006.
- Linnet MS, Devesa SS, Morgan GJ. The leukemias. In: Schottenfeld D, Fraumeni JF, eds. *Cancer Epidemiology and Prevention*. New York: Oxford University Press, Inc; 2006:841-871.
- Pui CH, Campana D, Pei D, et al. Treating childhood acute lymphoblastic leukemia without cranial irradiation. *N Engl J Med*. 2009;360:2730-2741.

37. Veerman AJ, Kamps WA, van den Berg H, et al; Dutch Childhood Oncology Group. Dexamethasone-based therapy for childhood acute lymphoblastic leukaemia: results of the prospective Dutch Childhood Oncology Group (DCOG) protocol ALL-9 (1997-2004). *Lancet Oncol.* 2009;10:957-966.
38. Pui CH, Behm FG, Raimondi SC, et al. Secondary acute myeloid leukemia in children treated for acute lymphoid leukemia. *N Engl J Med.* 1989;321:136-142.
39. Tsai HK, Mauch PM. Nodular lymphocyte-predominant hodgkin lymphoma. *Semin Radiat Oncol.* 2007;17:184-189.
40. Lossos IS, Alizadeh AA, Diehn M, et al. Transformation of follicular lymphoma to diffuse large-cell lymphoma: alternative patterns with increased or decreased expression of c-myc and its regulated genes. *Proc Natl Acad Sci U S A.* 2002;99:8886-8891.
41. National Lung Screening Trial Research Team, Aberle DR, Adams AM, et al. Reduced lung-cancer mortality with low-dose computed tomographic screening. *N Engl J Med.* 2011;365:395-409.
42. Chapple A, Ziebland S, McPherson A. Stigma, shame, and blame experienced by patients with lung cancer: qualitative study. *BMJ.* 2004;328:1470-1476.
43. Freedman DM, Miller BA, Tucker MA. New malignancies following melanoma of the skin, eye melanoma, and non-melanoma eye cancer. In: Curtis RE, Freedman DM, Ron E, et al, eds. *New Malignancies Among Cancer Survivors: SEER Cancer Registries, 1973-2000.* NIH Pub. No. 05-5302. Bethesda, MD: National Cancer Institute; 2006:339-362.
44. Albertsen PC, Hanley JA, Fine J. 20-year outcomes following conservative management of clinically localized prostate cancer. *JAMA.* 2005;293:2095-2101.
45. Lu-Yao GL, Albertsen PC, Moore DF, et al. Outcomes of localized prostate cancer following conservative management. *JAMA.* 2009;302:1202-1209.
46. Shappley WV, 3rd Kenfield SA, Kasperzyk JL, et al. Prospective study of determinants and outcomes of deferred treatment or watchful waiting among men with prostate cancer in a nationwide cohort. *J Clin Oncol.* 2009;27:4980-4985.
47. Kintzel PE, Chase PE, Schultz LM, O'Rourke TJ. Increased risk of metabolic syndrome, diabetes mellitus, and cardiovascular disease in men receiving androgen deprivation therapy for prostate cancer. *Pharmacotherapy.* 2008;28:1511-1522.
48. Townsend JS, Richardson LC, German RR. Incidence of testicular cancer in the United States, 1999-2004. *Am J Mens Health.* 2010;4:353-360.
49. Davies L, Ouellette M, Hunter M, Welch HG. The increasing incidence of small thyroid cancers: where are the cases coming from? *Laryngoscope.* 2010;120:2446-2451.
50. Davies L, Welch HG. Increasing incidence of thyroid cancer in the United States, 1973-2002. *JAMA.* 2006;295:2164-2167.
51. Aschebrook-Kilfoy B, Ward MH, Sabra MM, Devesa SS. Thyroid cancer incidence patterns in the United States by histologic type, 1992-2006. *Thyroid.* 2011;21:125-134.
52. Chen Z, Maricic M, Bassford TL, et al. Fracture risk among breast cancer survivors: results from the Women's Health Initiative Observational Study. *Arch Intern Med.* 2005;165:552-558.
53. Enewold L, Zhu K, Ron E, et al. Rising thyroid cancer incidence in the United States by demographic and tumor characteristics, 1980-2005. *Cancer Epidemiol Biomarkers Prev.* 2009;18:784-791.
54. Haymart MR, Banerjee M, Stewart AK, Koenig RJ, Birkmeyer JD, Griggs JJ. Use of radioactive iodine for thyroid cancer. *JAMA.* 2011;306:721-728.
55. Efstathiou JA, Spiegel DY, Shipley WU, et al. Long-term outcomes of selective bladder preservation by combined-modality therapy for invasive bladder cancer: the MGH experience. *Eur Urol.* 2012;61:705-711.
56. Hefey NM, Ahmed S, Flanagan MJ, et al. Superficial bladder cancer: progression and recurrence. *J Urol.* 1983;130:1083-1086.
57. Lutzeyer W, Rubben H, Dahm H. Prognostic parameters in superficial bladder cancer: an analysis of 315 cases. *J Urol.* 1982;127:250-252.
58. Gore JL, Saigal CS, Hanley JM, Schonlau M, Litwin MS; Urologic Diseases in America Project. Variations in reconstruction after radical cystectomy. *Cancer.* 2006;107:729-737.
59. Gilbert SM, Wood DP, Dunn RL, et al. Measuring health-related quality of life outcomes in bladder cancer patients using the Bladder Cancer Index (BCI). *Cancer.* 2007;109:1756-1762.
60. Barbera L, Seow H, Howell D, et al. Symptom burden and performance status in a population-based cohort of ambulatory cancer patients. *Cancer.* 2010;116:5767-5776.
61. Patrick DL, Ferketich SL, Frame PS, et al; National Institutes of Health State-of-the-Science Panel. National Institutes of Health State-of-the-Science Conference Statement: symptom management in cancer: pain, depression, and fatigue, July 15-17, 2002. *J Natl Cancer Inst Monogr.* 2004(32):9-16.
62. Gralow JR, Biermann JS, Farooki A, et al. NCCN Task Force Report: Bone Health in Cancer Care. *J Natl Compr Canc Netw.* 2009;7(suppl 3):S1-S32; quiz S33-S35.
63. Pfeilschifter J, Diehl J. Osteoporosis due to cancer treatment: pathogenesis and management. *J Clin Oncol.* 2000;18:1570-1593.
64. Tipples K, Robinson A. Optimal management of cancer treatment-induced bone loss: considerations for elderly patients. *Drugs Aging.* 2011;28:867-883.
65. Daniell HW, Dunn SR, Ferguson DW, Lomas G, Niazi Z, Stratte PT. Progressive osteoporosis during androgen deprivation therapy for prostate cancer. *J Urol.* 2000;163:181-186.
66. Mittan D, Lee S, Miller E, Perez RC, Basler JW, Bruder JM. Bone loss following hypogonadism in men with prostate cancer treated with GnRH analogs. *J Clin Endocrinol Metab.* 2002;87:3656-3661.
67. Smith MR. Osteoporosis during androgen deprivation therapy for prostate cancer. *Urology.* 2002;60(3 suppl 1):79-85; discussion 86.
68. Smith MR. Diagnosis and management of treatment-related osteoporosis in men with prostate carcinoma. *Cancer.* 2003;97(suppl 3):789-795.
69. Shahinian VB, Kuo YF, Freeman JL, Goodwin JS. Risk of fracture after androgen deprivation for prostate cancer. *N Engl J Med.* 2005;352:154-164.
70. Ewer MS, Ewer SM. Cardiotoxicity of anti-cancer treatments: what the cardiologist needs to know. *Nat Rev Cardiol.* 2010;7:564-575.
71. Steinherz LJ, Yahalom J. Cardiac toxicity. In: DeVita VT Jr, Hellman S, Rosenberg SA, eds. *Cancer: Principles and Practice of Oncology.* 6th ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2001:2904-2931.
72. Steinherz LJ, Steinherz PG, Tan CT, Heller G, Murphy ML. Cardiac toxicity 4 to 20 years after completing anthracycline therapy. *JAMA.* 1991;266:1672-1677.
73. Fuchs IB, Landt S, Bueler H, et al. Analysis of HER2 and HER4 in human myocardium to clarify the cardiotoxicity of trastuzumab (Herceptin). *Breast Cancer Res Treat.* 2003;82:23-28.
74. Klein PM, Dybdal N. Trastuzumab and cardiac dysfunction: update on preclinical studies. *Semin Oncol.* 2003;30(5 suppl 16):49-53.
75. Perez EA, Rodeheffer R. Clinical cardiac tolerability of trastuzumab. *J Clin Oncol.* 2004;22:322-329.
76. Eriksson F, Gagliardi G, Liedberg A, et al. Long-term cardiac mortality following radiation therapy for Hodgkin's disease: analysis with the relative seriality model. *Radiation Oncol.* 2000;55:153-162.
77. Harpham WS. Long-term survivorship late effects. In: Berger A, ed. *Principles and Practice of Supportive Oncology.* Philadelphia, PA: Lippincott-Raven; 1998:889-907.
78. Stewart JR, Fajardo LF, Gillette SM, Constance LS. Radiation injury to the heart. *Int J Radiat Oncol Biol Phys.* 1995;31:1205-1211.
79. Tukenova M, Guibout C, Oberlin O, et al. Role of cancer treatment in long-term overall and cardiovascular mortality after childhood cancer. *J Clin Oncol.* 2010;28:1308-1315.
80. Ahles TA, Saykin A. Cognitive effects of standard-dose chemotherapy in patients with cancer. *Cancer Invest.* 2001;19:812-820.
81. Ahles TA, Saykin AJ, Furstenberg CT, et al. Neuropsychologic impact of standard-dose systemic chemotherapy in long-term survivors of breast cancer and lymphoma. *J Clin Oncol.* 2002;20:485-493.
82. Ahles TA. Do systemic cancer treatments affect cognitive function? *Lancet Oncol.* 2004;5:270-271.
83. Burstein HJ. Cognitive side-effects of adjuvant treatments. *Breast.* 2007;16(suppl 2):S166-S168.
84. Schultz PN, Beck ML, Stava C, Vassilopoulos-Sellin R. Health profiles in 5836 long-term cancer survivors. *Int J Cancer.* 2003;104:488-495.
85. Tannock IF, Ahles TA, Ganz PA, van Dam FS. Cognitive impairment associated with chemotherapy for cancer: report of a workshop. *J Clin Oncol.* 2004;22:2233-2239.
86. Tchen N, Juffs HG, Downie FP, et al. Cognitive function, fatigue, and menopausal symptoms in women receiving adjuvant chemotherapy for breast cancer. *J Clin Oncol.* 2003;21:4175-4183.
87. Wefel JS, Lenzi R, Theriault RL, Davis RN, Meyers CA. The cognitive sequelae of standard-dose adjuvant chemotherapy in women with breast carcinoma: results of a prospective, randomized, longitudinal trial. *Cancer.* 2004;100:2292-2299.
88. Padovan CS, Yousry TA, Schleuning M, Holler E, Kolb HJ, Straube A. Neurological and neuroradiological findings in long-term

- survivors of allogeneic bone marrow transplantation. *Ann Neurol*. 1998;43:627-633.
89. Ganz PA. "Doctor, will the treatment you are recommending cause chemobrain?". *J Clin Oncol*. 2012;30:229-231.
 90. National Comprehensive Cancer Network. NCCN Clinical Practice Guidelines in Oncology. Distress Management. Version 1.2012. Fort Washington, PA: National Comprehensive Cancer Network; 2012.
 91. Mitchell AJ, Chan M, Bhatti H, et al. Prevalence of depression, anxiety, and adjustment disorder in oncological, haematological, and palliative-care settings: a meta-analysis of 94 interview-based studies. *Lancet Oncol*. 2011;12:160-174.
 92. Hofman M, Ryan JL, Figueroa-Moseley CD, Jean-Pierre P, Morrow GR. Cancer-related fatigue: the scale of the problem. *Oncologist*. 2007;12(suppl 1):4-10.
 93. Berger AM, Abernethy AP, Atkinson A, et al. Cancer-related fatigue. *J Natl Compr Canc Netw*. 2010;8:904-931.
 94. Cella DF, Lai JS, Chang CH, Peterman A, Slavin M. Fatigue in cancer patients compared with fatigue in the general United States population. *Cancer*. 2002;94:528-538.
 95. Dimeo FC. Effects of exercise on cancer-related fatigue. *Cancer*. 2001;92(suppl 6):1689-1693.
 96. Stasi R, Abriani L, Beccaglia P, Terzoli E, Amadori S. Cancer-related fatigue: evolving concepts in evaluation and treatment. *Cancer*. 2003;98:1786-1801.
 97. Fossa SD, Dahl AA, Loge JH. Fatigue, anxiety, and depression in long-term survivors of testicular cancer. *J Clin Oncol*. 2003;21:1249-1254.
 98. Hwang SS, Chang VT, Rue M, Kasimis B. Multidimensional independent predictors of cancer-related fatigue. *J Pain Symptom Manage*. 2003;26:604-614.
 99. Bower JE, Ganz PA, Aziz N, Fahey JL. Fatigue and proinflammatory cytokine activity in breast cancer survivors. *Psychosom Med*. 2002;64:604-611.
 100. Bower JE, Ganz PA, Aziz N, Fahey JL, Cole SW. T-cell homeostasis in breast cancer survivors with persistent fatigue. *J Natl Cancer Inst*. 2003;95:1165-1168.
 101. Knobel H, Loge JH, Nordoy T, et al. High level of fatigue in lymphoma patients treated with high dose therapy. *J Pain Symptom Manage*. 2000;19:446-456.
 102. Minton O, Stone P. How common is fatigue in disease-free breast cancer survivors? A systematic review of the literature. *Breast Cancer Res Treat*. 2008;112:5-13.
 103. Andrykowski MA, Schmidt JE, Salsman JM, Beacham AO, Jacobsen PB. Use of a case definition approach to identify cancer-related fatigue in women undergoing adjuvant therapy for breast cancer. *J Clin Oncol*. 2005;23:6613-6622.
 104. Sadler IJ, Jacobsen PB, Booth-Jones M, Belanger H, Weitzner MA, Fields KK. Preliminary evaluation of a clinical syndrome approach to assessing cancer-related fatigue. *J Pain Symptom Manage*. 2002;23:406-416.
 105. Ruffer JU, Flechtner H, Tralls P, et al; German Hodgkin Lymphoma Study Group. Fatigue in long-term survivors of Hodgkin's lymphoma; a report from the German Hodgkin Lymphoma Study Group (GHSG). *Eur J Cancer*. 2003;39:2179-2186.
 106. Broeckel JA, Jacobsen PB, Horton J, Balducci L, Lyman GH. Characteristics and correlates of fatigue after adjuvant chemotherapy for breast cancer. *J Clin Oncol*. 1998;16:1689-1696.
 107. Jacobsen PB, Stein K. Is fatigue a long-term side effect of breast cancer treatment? *Cancer Control*. 1999;6:256-263.
 108. Servaes P, van der Werf S, Prins J, Verhaagen S, Bleijenberg G. Fatigue in disease-free cancer patients compared with fatigue in patients with chronic fatigue syndrome. *Support Care Cancer*. 2001;9:11-17.
 109. Holzner B, Kemmler G, Meraner V, et al. Fatigue in ovarian carcinoma patients: a neglected issue? *Cancer*. 2003;97:1564-1572.
 110. Hann DM, Jacobsen PB, Martin SC, Kornish LE, Azzarello LM, Fields KK. Fatigue in women treated with bone marrow transplantation for breast cancer: a comparison with women with no history of cancer. *Support Care Cancer*. 1997;5:44-52.
 111. Brown JC, Huedo-Medina TB, Pescatello LS, et al. Efficacy of exercise interventions in modulating cancer-related fatigue among adult cancer survivors: a meta-analysis. *Cancer Epidemiol Biomarkers Prev*. 2011;20:123-133.
 112. Jacobsen PB, Donovan KA, Vadaparampil ST, et al. Systematic review and meta-analysis of psychological and activity-based interventions for cancer-related fatigue. *Health Psychol*. 2007;26:660-667.
 113. Minton O, Richardson A, Sharpe M, et al. Psychostimulants for the management of cancer-related fatigue: a systematic review and meta-analysis. *J Pain Symptom Manage*. 2011;41:761-767.
 114. Humphris GM, Rogers S, McNally D, Lee-Jones C, Brown J, Vaughan D. Fear of recurrence and possible cases of anxiety and depression in orofacial cancer patients. *Int J Oral Maxillofac Surg*. 2003;32:486-491.
 115. Lee-Jones C, Humphris G, Dixon R, Hatcher MB. Fear of cancer recurrence—a literature review and proposed cognitive formulation to explain exacerbation of recurrence fears. *Psychooncology*. 1997;6:95-105.
 116. Mehta SS, Lubeck DP, Pasta DJ, Litwin MS. Fear of cancer recurrence in patients undergoing definitive treatment for prostate cancer: results from CaPSURE. *J Urol*. 2003;170:1931-1933.
 117. Northouse LL. Mastectomy patients and the fear of cancer recurrence. *Cancer Nurs*. 1981;4:213-220.
 118. Vickberg SM. The Concerns About Recurrence Scale (CARS): a systematic measure of women's fears about the possibility of breast cancer recurrence. *Ann Behav Med*. 2003;25:16-24.
 119. Baker F, Denniston M, Smith T, West MM. Adult cancer survivors: how are they faring? *Cancer*. 2005;104(suppl 11):2565-2576.
 120. Mellon S, Kershaw TS, Northouse LL, Freeman-Gibb L. A family-based model to predict fear of recurrence for cancer survivors and their caregivers. *Psychooncology*. 2007;16:214-223.
 121. Jeruss JS, Woodruff TK. Preservation of fertility in patients with cancer. *N Engl J Med*. 2009;360:902-911.
 122. Knopf MT. The influence of endocrine effects of adjuvant therapy on quality of life outcomes in younger breast cancer survivors. *Oncologist*. 2006;11:96-110.
 123. Hudson MM. Reproductive outcomes for survivors of childhood cancer. *Obstet Gynecol*. 2010;116:1171-1183.
 124. Huddart RA, Norman A, Moynihan C, et al. Fertility, gonadal and sexual function in survivors of testicular cancer. *Br J Cancer*. 2005;93:200-207.
 125. Nieman CL, Kazer R, Brannigan RE, et al. Cancer survivors and infertility: a review of a new problem and novel answers. *J Support Oncol*. 2006;4:171-178.
 126. van den Beuken-van Everdingen MH, de Rijke JM, Kessels AG, Schouten HC, van Kleef M, Patijn J. Prevalence of pain in patients with cancer: a systematic review of the past 40 years. *Ann Oncol*. 2007;18:1437-1449.
 127. Green CR, Hart-Johnson T, Loeffler DR. Cancer-related chronic pain: examining quality of life in diverse cancer survivors. *Cancer*. 2011;117:1994-2003.
 128. Argvriou AA, Koltzenburg M, Polychronopoulos P, Papapetropoulos S, Kalofonos HP. Peripheral nerve damage associated with administration of taxanes in patients with cancer. *Crit Rev Oncol Hematol*. 2008;66:218-228.
 129. World Health Organization. Cancer Pain Relief: With a Guide to Opioid Availability, 2nd ed. Geneva, Switzerland: World Health Organization; 1996.
 130. National Comprehensive Cancer Network. NCCN Clinical Practice Guidelines in Oncology. Adult Cancer Pain. Version 2.2011. Fort Washington, PA: National Comprehensive Cancer Network; 2011.
 131. Liles A, Blatt J, Morris D, et al; Children's Oncology Group. Monitoring pulmonary complications in long-term childhood cancer survivors: guidelines for the primary care physician. *Cleve Clin J Med*. 2008;75:531-539.
 132. Mertens AC, Yasui Y, Liu Y, et al; Childhood Cancer Survivor Study. Pulmonary complications in survivors of childhood and adolescent cancer. A report from the Childhood Cancer Survivor Study. *Cancer*. 2002;95:2431-2441.
 133. Jenkins R, Schover LR, Fouladi RT, et al. Sexuality and health-related quality of life after prostate cancer in African-American and white men treated for localized disease. *J Sex Marital Ther*. 2004;30:79-93.
 134. Neese LE, Schover LR, Klein EA, Zippe C, Kupelian PA. Finding help for sexual problems after prostate cancer treatment: a phone survey of men's and women's perspectives. *Psychooncology*. 2003;12:463-473.
 135. Frumovitz M, Sun CC, Schover LR, et al. Quality of life and sexual functioning in cervical cancer survivors. *J Clin Oncol*. 2005;23:7428-7436.
 136. Ganz PA, Rowland JH, Desmond K, Meyerowitz BE, Wyatt GE. Life after breast cancer: understanding women's health-related quality of life and sexual functioning. *J Clin Oncol*. 1998;16:501-514.
 137. Kornblith AB, Ligibel J. Psychosocial and sexual functioning of survivors of breast cancer. *Semin Oncol*. 2003;30:799-813.
 138. Siegel T, Moul JW, Spevak M, Alvard WG, Costabile RA. The development of erectile dysfunction in men treated for prostate cancer. *J Urol*. 2001;165:430-435.
 139. Schover LR. Sexuality and fertility after cancer. *Hematology Am Soc Hematol Educ Program*. 2005:523-527.

140. Meier DE, Brawley OW. Palliative care and the quality of life. *J Clin Oncol*. 2011; 29:2750-2752.
141. Morrison RS, Meier DE. America's Care of Serious Illness: A State-by-State Report Card on Access to Palliative Care in Our Nation's Hospitals. New York, NY: Center to Advance Palliative Care; 2011.
142. Hui D, Elsayem A, De la Cruz M, et al. Availability and integration of palliative care at US cancer centers. *JAMA*. 2010; 303:1054-1061.
143. Fashoyin-Aje LA, Martinez KA, Dy SM. New patient-centered care standards from the Commission on Cancer: opportunities and challenges [published online ahead of print March 20, 2012]. *J Support Oncol*.
144. Jacobs LA, Palmer SC, Schwartz LA, et al. Adult cancer survivorship: evolution, research, and planning care. *CA Cancer J Clin*. 2009;59:391-410.
145. Salz T, Oeffinger KC, McCabe MS, Layne TM, Bach PB. Survivorship care plans in research and practice [published online ahead of print January 12, 2012]. *CA Cancer J Clin*. doi: 10.3322/caac.20142.
146. Hede K. Assessing survivorship care plans. *J Natl Cancer Inst*. 2011;103:1214-1215.
147. Ferrell BR, Hassey Dow K. Quality of life among long-term cancer survivors. *Oncology (Williston Park)*. 1997;11:565-568, 571; discussion 572, 575-576.
148. Ganz PA, Desmond KA, Leedham B, Rowland JH, Meyerowitz BE, Belin TR. Quality of life in long-term, disease-free survivors of breast cancer: a follow-up study. *J Natl Cancer Inst*. 2002;94:39-49.
149. Ashing-Giwa KT, Tejero JS, Kim J, Padilla GV, Hellemann G. Examining predictive models of HRQOL in a population-based, multiethnic sample of women with breast carcinoma. *Qual Life Res*. 2007;16:413-428.
150. Mols F, Vingerhoets AJ, Coebergh JW, van de Poll-Franse LV. Quality of life among long-term breast cancer survivors: a systematic review. *Eur J Cancer*. 2005; 41:2613-2619.
151. Zeltzer LK, Lu Q, Leisenring W, et al. Psychosocial outcomes and health-related quality of life in adult childhood cancer survivors: a report from the childhood cancer survivor study. *Cancer Epidemiol Biomarkers Prev*. 2008;17:435-446.
152. Bowen DJ, Alfano CM, McGregor BA, et al. Possible socioeconomic and ethnic disparities in quality of life in a cohort of breast cancer survivors. *Breast Cancer Res Treat*. 2007;106:85-95.
153. Hewitt M, Rowland JH, Yancik R. Cancer survivors in the United States: age, health, and disability. *J Gerontol A Biol Sci Med Sci*. 2003;58:82-91.
154. Sweeney C, Schmitz KH, Lazovich D, Virnig BA, Wallace RB, Folsom AR. Functional limitations in elderly female cancer survivors. *J Natl Cancer Inst*. 2006;98: 521-529.
155. Zebrack BJ, Chesler MA. Quality of life in childhood cancer survivors. *Psychooncology*. 2002;11:132-141.
156. Bower JE, Meyerowitz BE, Desmond KA, Bernards CA, Rowland JH, Ganz PA. Perceptions of positive meaning and vulnerability following breast cancer: predictors and outcomes among long-term breast cancer survivors. *Ann Behav Med*. 2005; 29:236-245.
157. Calle EE, Rodriguez C, Walker-Thurmond K, Thun MJ. Overweight, obesity, and mortality from cancer in a prospectively studied cohort of U.S. adults. *N Engl J Med*. 2003;348:1625-1638.
158. McTiernan A, Irwin M, Vonrungen V. Weight, physical activity, diet, and prognosis in breast and gynecologic cancers. *J Clin Oncol*. 2010;28:4074-4080.
159. Wei EK, Wolin KY, Colditz GA. Time course of risk factors in cancer etiology and progression. *J Clin Oncol*. 2010;28: 4052-4057.
160. Winzer BM, Whiteman DC, Reeves MM, Paratz JD. Physical activity and cancer prevention: a systematic review of clinical trials. *Cancer Causes Control*. 2011;22: 811-826.
161. Do KA, Johnson MM, Lee JJ, et al. Longitudinal study of smoking patterns in relation to the development of smoking-related secondary primary tumors in patients with upper aerodigestive tract malignancies. *Cancer*. 2004;101:2837-2842.
162. Parsons A, Daley A, Begh R, Aveyard P. Influence of smoking cessation after diagnosis of early stage lung cancer on prognosis: systematic review of observational studies with meta-analysis. *BMJ*. 2010; 340:b5569.
163. Blanchard CM, Stein KD, Baker F, et al. Association between current lifestyle behaviors and health-related quality of life in breast, colorectal, and prostate cancer survivors. *Psychol Health*. 2004;19:1-13.
164. Courneya KS, Mackey JR, Bell GJ, Jones LW, Field CJ, Fairey AS. Randomized controlled trial of exercise training in postmenopausal breast cancer survivors: cardiopulmonary and quality of life outcomes. *J Clin Oncol*. 2003;21:1660-1668.
165. Mustian KM, Morrow GR, Carroll JK, Figueroa-Moseley CD, Jean-Pierre P, Williams GC. Integrative nonpharmacologic behavioral interventions for the management of cancer-related fatigue. *Oncologist*. 2007;12(suppl 1):52-67.
166. Kushi LH, Doyle C, McCullough M, et al; American Cancer Society, 2010 Nutrition and Physical Activity Guidelines Advisory Committee. American Cancer Society Guidelines on nutrition and physical activity for cancer prevention: reducing the risk of cancer with healthy food choices and physical activity. *CA Cancer J Clin*. 2012;62:30-67.
167. Courneya KS. Physical activity in cancer survivors: a field in motion. *Psychooncology*. 2009;18:337-342.
168. Irwin ML, Mayne ST. Impact of nutrition and exercise on cancer survival. *Cancer J*. 2008;14:435-441.
169. Denlinger CS, Engstrom PF. Colorectal cancer survivorship: movement matters. *Cancer Prev Res (Phila)*. 2011;4:502-511.
170. Toles M, Demark-Wahnefried W. Nutrition and the cancer survivor: evidence to guide oncology nursing practice. *Semin Oncol Nurs*. 2008;24:171-179.
171. Kushi LH, Byers T, Doyle C, et al; American Cancer Society 2006 Nutrition and Physical Activity Guidelines Advisory Committee. American Cancer Society Guidelines on Nutrition and Physical Activity for cancer prevention: reducing the risk of cancer with healthy food choices and physical activity. *CA Cancer J Clin*. 2006;56:254-281; quiz 313-314.
172. Barrera S, Demark-Wahnefried W. Nutrition during and after cancer therapy. *Oncology (Williston Park)*. 2009;23(2 suppl Nurse Ed):15-21.
173. Burke L, Miller LA, Saad A, Abraham J. Smoking behaviors among cancer survivors: an observational clinical study. *J Oncol Pract*. 2009;5:6-9.
174. National Center for Health Statistics. National Health Interview Survey, 2000, 2005, and 2008. Hyattsville, MD: National Center for Health Statistics, Centers for Disease Control and Prevention; 2009.
175. Sanderson Cox L, Patten CA, Ebbert JO, et al. Tobacco use outcomes among patients with lung cancer treated for nicotine dependence. *J Clin Oncol*. 2002;20: 3461-3469.
176. Yabroff KR, Kim Y. Time costs associated with informal caregiving for cancer survivors. *Cancer*. 2009;115(suppl 18): 4362-4373.
177. van Ryn M, Sanders S, Kahn K, et al. Objective burden, resources, and other stressors among informal cancer caregivers: a hidden quality issue? *Psychooncology*. 2011;20:44-52.
178. Northouse LL, Katapodi MC, Song L, Zhang L, Mood DW. Interventions with family caregivers of cancer patients: meta-analysis of randomized trials. *CA Cancer J Clin*. 2010;60:317-339.
179. Ganz PA. A teachable moment for oncologists: cancer survivors, 10 million strong and growing! *J Clin Oncol*. 2005;23: 5458-5460.
180. Humpel N, Magee C, Jones SC. The impact of a cancer diagnosis on the health behaviors of cancer survivors and their family and friends. *Support Care Cancer*. 2007;15: 621-630.
181. Kim Y, Carver CS, Spillers RL, Love-Ghaf-fari M, Kaw CK. Dyadic effects of fear of recurrence on the quality of life of cancer survivors and their caregivers. *Qual Life Res*. 2012;21:517-525.
182. Given BA, Sherwood P, Given CW. Support for caregivers of cancer patients: transition after active treatment. *Cancer Epidemiol Biomarkers Prev*. 2011;20: 2015-2021.
183. Northouse LL, Mood D, Templin T, Mellon S, George T. Couples' patterns of adjustment to colon cancer. *Soc Sci Med*. 2000; 50:271-284.
184. Hagedoorn M, Buunk BP, Kuijer RG, Wobbles T, Sanderman R. Couples dealing with cancer: role and gender differences regarding psychological distress and quality of life. *Psychooncology*. 2000;9:232-242.
185. Kim Y, Loscalzo MJ, Wellisch DK, Spillers RL. Gender differences in caregiving stress among caregivers of cancer survivors. *Psychooncology*. 2006;15:1086-1092.
186. Matthews B, Baker F, Spillers R. Family caregivers and indicators of cancer-related distress. *Psychol Health Med*. 2003; 8:46-56.
187. Kim Y, Schulz R, Carver CS. Benefit-finding in the cancer caregiving experience. *Psychosom Med*. 2007;69:283-291.
188. Carver CS, Antoni MH. Finding benefit in breast cancer during the year after diagnosis predicts better adjustment 5 to 8 years after diagnosis. *Health Psychol*. 2004;23: 595-598.