VOLUME 27 · NUMBER 17 · JUNE 10 2009

JOURNAL OF CLINICAL ONCOLOGY

ORIGINAL REPORT

Future of Cancer Incidence in the United States: Burdens Upon an Aging, Changing Nation

Benjamin D. Smith, Grace L. Smith, Arti Hurria, Gabriel N. Hortobagyi, and Thomas A. Buchholz

From the Radiation Oncology Flight, Wilford Hall Medical Center, Lackland Air Force Base; Department of Radiation Oncology, The University of Texas M. D. Anderson Cancer Center, Houston, TX; and the Department of Medical Oncology, City of Hope Cancer Center, Duarte, CA.

Submitted November 3, 2008; accepted February 13, 2009; published online ahead of print at www.jco.org on April 27, 2009.

Presented in part at the 22nd San Antonio Breast Cancer Symposium in December 10-14, 2008.

Authors' disclosures of potential conflicts of interest and author contributions are found at the end of this article.

Corresponding author: Benjamin Smith, MD, 2200 Bergquist Dr, Ste #1, Lackland AFB, TX 78236; e-mail: bensmith@alumni.rice.edu.

The Appendix is included in the full-text version of this article, available online at www.jco.org. It is not included in the PDF version (via Adobe® Reader®).

0732-183X/09/2717-2758/$20.00

DOI: 10.1200/JCO.2008.20.8983

ABSTRACT

Purpose
By 2030, the United States' population will increase to approximately 365 million, including 72 million older adults (age ≥ 65 years) and 157 million minority individuals. Although cancer incidence varies by age and race, the impact of demographic changes on cancer incidence has not been fully characterized. We sought to estimate the number of cancer patients diagnosed in the United States through 2030 by age and race.

Methods
Current demographic-specific cancer incidence rates were calculated using the Surveillance Epidemiology and End Results database. Population projections from the Census Bureau were used to project future cancer incidence through 2030.

Results
From 2010 to 2030, the total projected cancer incidence will increase by approximately 45%, from 1.6 million in 2010 to 2.3 million in 2030. This increase is driven by cancer diagnosed in older adults and minorities. A 67% increase in cancer incidence is anticipated for older adults, compared with an 11% increase for younger adults. A 99% increase is anticipated for minorities, compared with a 31% increase for whites. From 2010 to 2030, the percentage of all cancers diagnosed in older adults will increase from 61% to 70%, and the percentage of all cancers diagnosed in minorities will increase from 21% to 28%.

Conclusion
Demographic changes in the United States will result in a marked increase in the number of cancer diagnoses over the next 20 years. Continued efforts are needed to improve cancer care for older adults and minorities.

J Clin Oncol 27:2758-2765. © 2009 by American Society of Clinical Oncology

INTRODUCTION

One of the most defining sociodemographic changes ongoing in the United States is the dramatic increase in the number of older adults and minorities. Specifically, the number of adults age 65 years or older increased from 25 million in 1980 to 35 million in 2000, and is further expected to increase to 72 million by 2030 as the baby boomer generation ages (Figs 1A, 1B).[1-3] Similarly, the number of minorities increased from 46 million in 1980 to 83 million in 2000, and is further expected to increase to 157 million in 2030 (Figs 1C, 1D).[1-3] As cancer occurs more commonly in older adults, the aging of the United States' population is expected to markedly increase the number of cancer diagnoses.[4] The increase in minorities is also likely to impact cancer care, particularly as prior evidence suggests that certain minorities have higher cancer incidence rates and lower cancer survival rates as compared with white people.[5] In addition, minorities and older adults represent important populations that may be particularly vulnerable to suboptimal cancer care, because both groups have been under-represented in cancer clinical trials[6] and are also subject to disparities in cancer treatment.[7,8]

These demographic shifts in our society are thus expected to exert a substantial stressor on the health care system, and they highlight the need to address shortcomings in cancer clinical trials and disparities in cancer care. Quantifying the projected number of cancer cases in older and minority patients is fundamental for defining the expected societal burden of cancer, and, accordingly, guiding research and health policy priorities. However, to the best of our knowledge, specific long-term incidence projections for cancer in the United States have not been fully quantified. To address this need, we used data from the Surveillance Epidemiology and End Results (SEER) project and the United

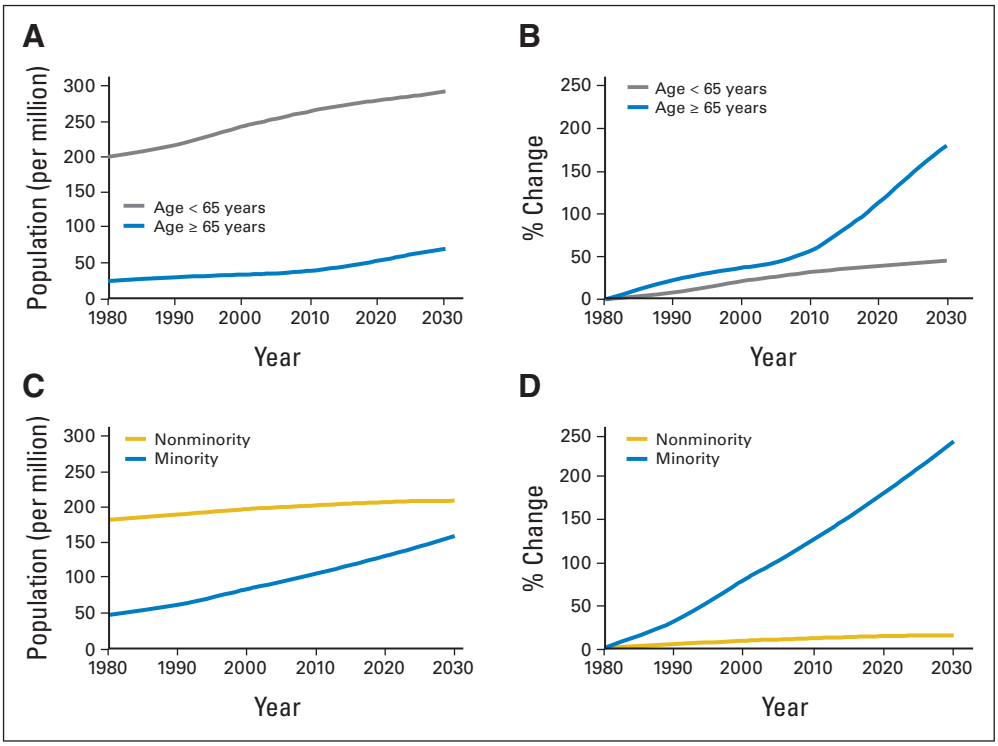

Fig 1. Population trends in the United States by age and race/origin, 1980 to 2030. Data for 1980 and 1990 are derived from the United States Census for these years.[1,3] Data from 2000 onward are derived from the 2000 Census and projections for population growth thereafter.[2]

States Census bureau to project the anticipated number of cancer cases by age, sex, race, and origin through 2030.

METHODS

In August 2008, the United States' Census Bureau released updated projections for population growth through 2050,[2] which were derived from current data regarding birth rates, death rates, and immigration patterns. The projections reported the estimated number of individuals for each age from 0 through 100 years old stratified by sex, race, and origin. Race categories included white, black, Asian, Pacific Islander, American Indian/Alaska Native, and multiracial. Origin categories included either non-Hispanic or Hispanic. Thus, there are 12 potential combinations of race and origin.

Current age-, sex-, race-, and origin-specific cancer incidence rates were calculated for the United States population using the SEER-17 database, which represents approximately 26% of the United States population and includes the following: Connecticut, New Jersey, Atlanta, Rural Georgia, Kentucky, Louisiana, Detroit, Iowa, New Mexico, Utah, Los Angeles, San Francisco-Oakland, San Jose-Monterey, Greater California, Seattle, Alaska Native Tumor Registry, and Hawaii.[9] Incidence rates were calculated from 2003 through 2005, which are the three most recent years for which data is available. Cancer sites included all invasive cancers combined (excluding nonmelanoma cutaneous cancer), 23 individual cancer sites, and in situ breast cancer. For incidence calculations, age categories included: 0 years, 1 to 4 years, 5 to 9 years, 10 to 14 years, and so on through 80 to 84 years, with patients age 85 years and older in a single group. Race categories included white, black, Asian/Pacific Islander, and American Indian/Alaska Native. Origin categories included non-Hispanic and Hispanic. Calculated incidence rates were adjusted for delayed reporting according to the method of Clegg et al.[10,11]

Cancer incidence projections through 2030 were calculated by multiplying the age-, sex-, race-, and origin-specific population projections by the age-, sex-, race-, and origin-specific cancer incidence rates. To account for differences between the census projections and the SEER-based cancer incidence rates, the population projections for Asians and Pacific Islanders were collapsed into a single group. In addition, because SEER does not report cancer incidence rates for multiracial individuals, these individuals were assumed to have a cancer incidence rate equal to that of the total population not adjusted for race. For the purposes of this report, we used the US Census Bureau definition of minority, which was defined as non-white race or Hispanic origin of any race.[2]

The assumption underlying this method for cancer incidence projection is that the age-, sex-, race-, and origin-specific cancer incidence rates averaged over the years 2003 through 2005 will remain constant through 2030. Recent epidemiologic data suggests that this is a reasonable assumption, as the American Cancer Society reported that the age-adjusted incidence of cancer from all sites combined has remained relatively constant for men since 1995 and for women since 1999.[12] In addition, as shown in Figure 2, age-adjusted cancer incidence rates by race and sex have remained stable since 1997 for all population groups except black men, where the incidence of cancer has decreased by 13% since 1997.

Analyses were conducted using SEER*Stat version 6.4.4 (www.seer.cancer.gov/seerstat) and SAS version 9.1 (SAS Institute, Cary, NC). This study was approved by the Wilford Hall Medical Center institutional review board.

RESULTS

All Cancer Sites

From 1980 through 2000, the United States population grew by 23% (from 227 million to 279 million), whereas the total yearly cancer incidence increased by 66% (from 807,000 to 1.34 million). From 2010 to 2030, the US population is expected to grow by an additional 19% (from 305 million to 365 million), and the total expected cancer incidence is expected to increase by an additional 45% (from 1.6 million to 2.3 million; Fig 3). This increased incidence is driven disproportionately by instances diagnosed in those patients age ≥ 65 years and in minorities. Specifically, between 2010 and 2030, a 67% increase in cancer incidence is anticipated for patients age 65 years or

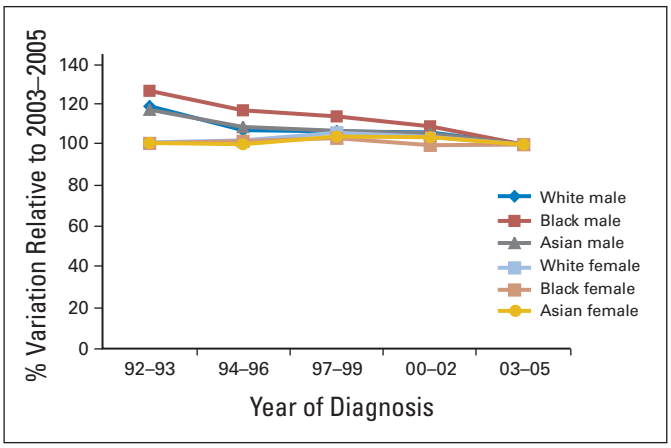

Fig 2. Variation in cancer incidence, 1992 to 2005. All rates are age-adjusted using the year 2000 standard population. All sites of invasive cancer (excluding nonmelanoma skin cancer) were included in this analysis.

older (1.0 million to 1.6 million instances), compared with only an 11% increase in cancer incidence anticipated for patients younger than the age of 65 years (0.63 million to 0.67 million instances; Figs 4A, 4B). From 2010 to 2030, the percent of all cancers diagnosed in older adults is expected to increase from 61% to 70%.

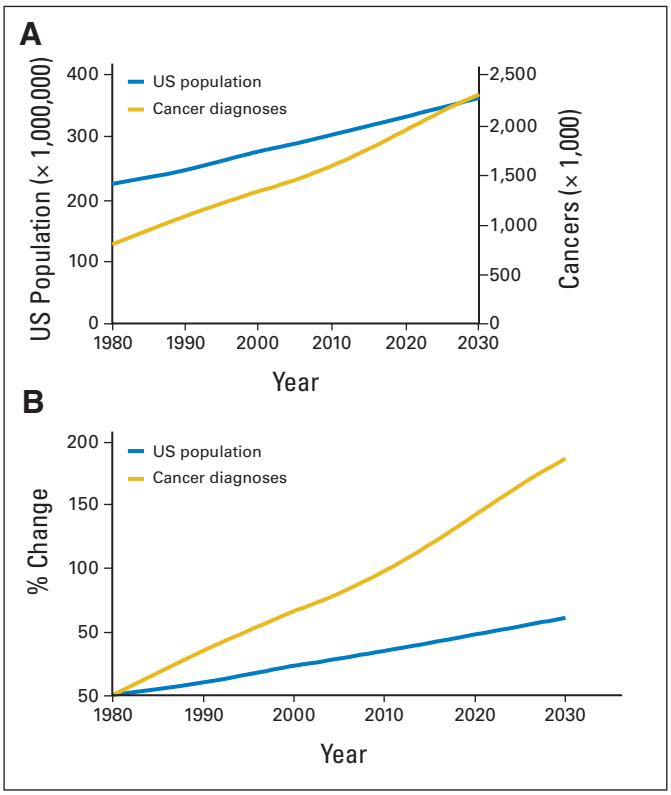

Fig 3. Historic and projected growth in the United States population and all invasive cancers by year, 1980 to 2030. Data from 1980 and 1990 are estimated using data from the Surveillance, Epidemiology, and End Results database.[9] Data from 2000 to 2030 are estimated as described in Methods. All sites of invasive cancer (excluding nonmelanoma skin cancer) were included in this analysis.

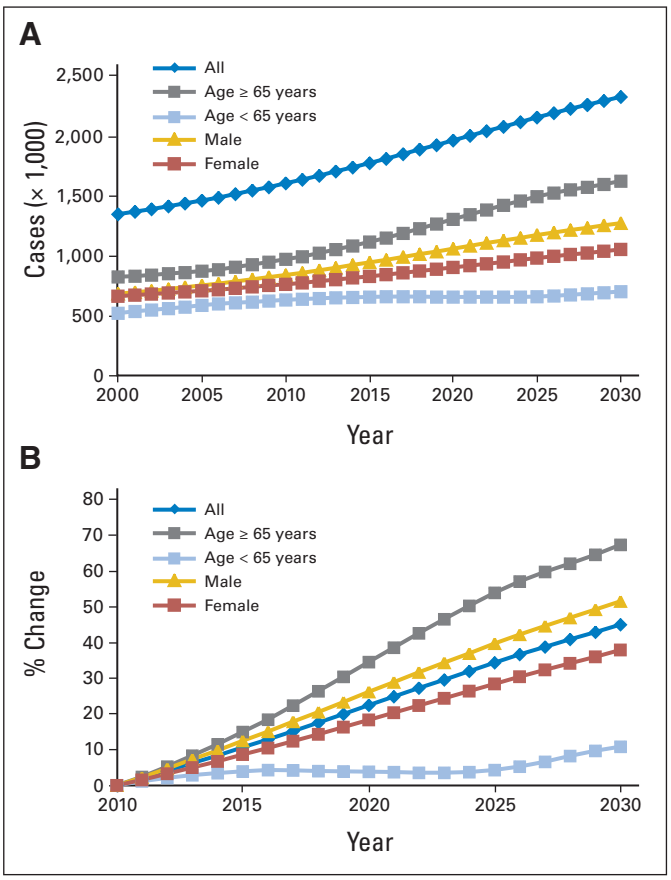

Fig 4. Projected cases of all invasive cancers in the United States by age and sex. (*) Nonmelanoma skin cancers were excluded from projections.

With respect to race and origin, a 99% increase in cancer incidence is anticipated for minorities (0.33 million to 0.66 million instances), compared with only a 31% increase anticipated for non-Hispanic whites (1.3 million to 1.7 million instances; Fig 5A). The increase in cancer incidence for minorities may be attributed to an increased incidence of 64% for blacks (non-Hispanic), 132% for Asian/Pacific Islanders (non-Hispanic), 76% for American Indian/Alaska Natives (non-Hispanic), 101% for multiracial (non-Hispanic), and 142% for Hispanics of any race (Fig 5B). From 2010 to 2030, the percentage of all cancers diagnosed in minorities is expected to increase from 21% to 28%.

Site-Specific Data

Based on absolute case numbers for cancer incidence, the leading cancer sites in the year 2030 are still expected to be prostate (382,000), lung (189,000), and colorectum (136,000) in men; and breast (294,000 invasive and 67,000 in situ), lung (149,000), and colorectum (122,000) in women. Cancer sites with the highest percentage of increase between 2010 through 2030 are expected to be stomach (67%), liver (59%), myeloma (57%), prostate (55%), pancreas (55%), bladder (54%), lung (52%), and colorectum (52%). For patients age ≥ 65, a more than 50% increase in incidence by 2030 was projected for every single cancer site examined. In addition, for Asian/Pacific Islanders and Hispanics, a more than 100% increase in incidence by 2030 was projected for the majority of individual cancer sites examined (Table 1

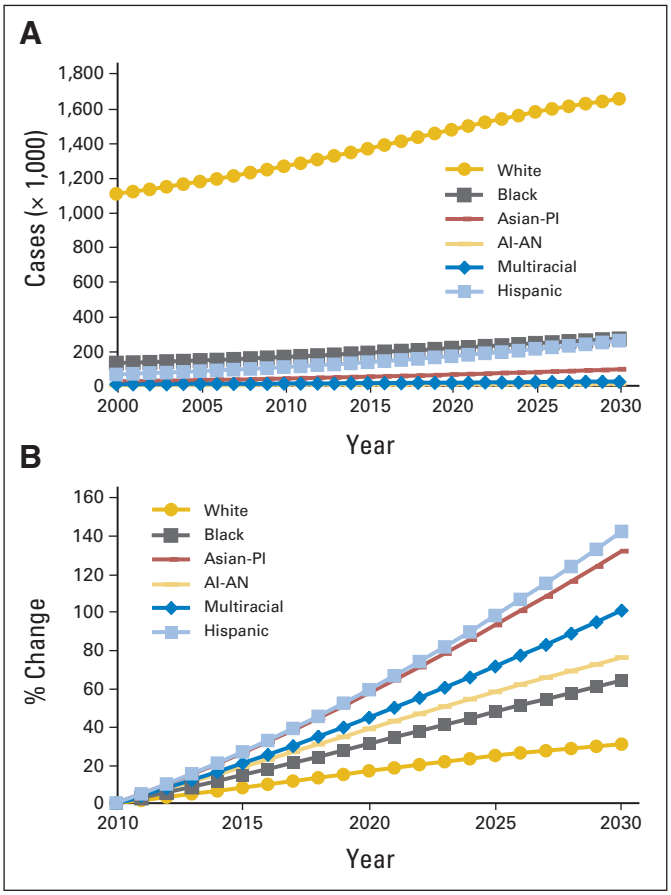

Fig 5. Projected cases of all invasive cancers in the United States by race and origin. (*) Nonmelanoma skin cancers were excluded from projections. The Hispanic origin group contains individuals of any race. The race groups white, black, Asian/Pacific Islander (PI), American Indian (AI)/Alaska Native (AN), and multiracial contain only non-Hispanic individuals.

and Appendix Table A1, online only). Projections by individual cancer site are presented in Appendix Figure A1 (online only).

DISCUSSION

The burden of cancer on our population is expected to rise sharply over the next 20 years. Overall cancer incidence is expected to increase by 45% between 2010 and 2030, with the greatest increase borne by older adults and minorities. By 2030, approximately 70% of all cancers will be diagnosed in older adults, and 28% of all cancers will be diagnosed in minorities. Alarmingly, certain cancer sites with particularly high mortality rates, such as liver, stomach, pancreas, and lung, will be among those with the greatest relative increase in incidence. Therefore, unless substantial improvements in cancer therapy and/or prevention strategies emerge, the number of cancer deaths may also grow dramatically over the next 20 years.

Efforts to date to address the rising number of older adults and minorities diagnosed with cancer have met with only modest success. For example, in 1999 the Institute of Medicine released a report entitled *The Unequal Burden of Cancer: An Assessment of NIH Research and Programs for Ethnic Minorities and the Medically Underserved*[13] which included 22 specific recommendations for policy initiatives to improve cancer treatment for minorities and the medically underserved through promotion of National Institutes of Health research efforts, communication of research findings, and enhancement of clinical trial recruitment and retention. Despite these efforts, disparities in cancer treatment and outcomes have persisted. For example, a recent study suggested that cancer treatment disparities did not improve between 1992 and 2002, with minorities still more likely to receive substandard care for breast, lung, prostate, and colorectal cancers.[8] Further, blacks have continued to experience a disproportionate burden of both cancer incidence and mortality,[5] and clinical trials have failed to accrue sufficient numbers of minorities and older adults.[6,14]

Looking to the future, several novel programs are seeking to address shortcomings of the past. For example, the Institute of Medicine recently completed a seminal report entitled *Retooling for an Aging America: Building the Health Care Workforce*[15] that provided 13 concrete policy suggestions to prepare the medical system for the coming surge in older adults. With respect to cancer specifically, the American Society of Clinical Oncology, in conjunction with the John A. Hartford Foundation, recently initiated support for 10 fellowship programs in geriatrics and oncology, which has already resulted in the successful training of 28 geriatric oncologists and the formation of the Cancer and Aging Research Group. To address disparities in cancer care experienced by minorities, Congress recently approved the Patient Outreach Navigator and Chronic Disease Prevention Act of 2005, which is being used by the National Cancer Institute's Center to Reduce Cancer Health Disparities to support development of patient navigator programs to narrow race-based disparities by promoting culturally sensitive cancer care.[16]

Such preparation for the future is critically important, as the striking increase in cancer incidence, and correspondingly an anticipated increase in cancer prevalence, could exceed the capacity of the current health care system. For example, studies from the American Society of Clinical Oncology (ASCO) and the Institute of Medicine project substantial shortages of medical oncologists and geriatricians over the next 20 years.[17,18] Ironically, the aging of the American population may also contribute to a reduction in the number of physicians, as more physicians enter retirement themselves.[4] In addition to a shortage of physicians, the anticipated increase in cancer incidence will require a major investment in the infrastructure needed to deliver cancer care. Finally, the increasing incidence of cancer, coupled with the rising cost to treat an individual cancer patient,[19] could exert a synergistic effect on growth of cancer costs.

To address the expected impact of increasing cancer incidence on the health care system, several additional interventions should be considered. For example, professional societies such as the American Association of Medical Colleges and ASCO are already actively exploring strategies to increase the total number of physicians trained and recruitment to oncology-oriented specialties.[4,20] Given the marked increase in cancer diagnoses in older adults, coupled with current and projected shortfalls in the number of geriatricians, it may also be worthwhile to routinely integrate geriatrics training into oncology fellowship programs. In addition, in an effort to counter the expected rise in cancer cases, prevention strategies of proven efficacy need to be promoted, such as vaccination for hepatitis B and human papillomavirus[21]; chemoprevention with tamoxifen and raloxifene; social interventions such as tobacco and alcohol cessation; and removal of

Table 1. Projected No. of Cancer Patients From 2010 Through 2030 by Age and Sex

Cancer Site and Year	All		Age 65+		Women		Men	
	No.	%*	No.	%*	No.	%*	No.	%*
All								
2010	1,599,000	—	967,000	—	761,000	—	838,000	—
2020	1,957,000	22	1,302,000	35	900,000	18	1,057,000	26
2030	2,318,000	45	1,618,000	67	1,049,000	38	1,269,000	51
Bladder								
2010	75,000	—	53,000	—	19,000	—	57,000	—
2020	94,000	25	70,000	33	22,000	20	72,000	26
2030	116,000	54	89,000	68	27,000	46	89,000	57
Breast								
Invasive								
2010	228,000	—	114,000	—	226,000	—	2,000	—
2020	264,000	16	150,000	32	262,000	16	2,000	25
2030	297,000	30	179,000	57	294,000	30	3,000	48
In situ								
2010	53,000	—	25,000	—	53,000	—	200	—
2020	61,000	14	33,000	33	61,000	14	200	19
2030	67,000	26	39,000	56	67,000	26	300	37
Cervix								
2010	13,000	—	4,000	—	13,000	—	—	—
2020	15,000	15	5,000	40	15,000	15	—	—
2030	17,000	31	6,000	76	17,000	31	—	—
CNS								
2010	22,000	—	10,000	—	10,000	—	12,000	—
2020	26,000	16	13,000	33	12,000	15	14,000	17
2030	29,000	31	16,000	63	13,000	30	16,000	32
Colorectum								
2010	168,000	—	106,000	—	81,000	—	87,000	—
2020	208,000	24	142,000	34	98,000	21	110,000	26
2030	255,000	52	182,000	72	120,000	48	135,000	56
Esophagus								
2010	16,000	—	11,000	—	4,000	—	12,000	—
2020	20,000	25	15,000	35	5,000	23	16,000	25
2030	24,000	49	18,000	68	6,000	49	18,000	49
Hodgkin's lymphoma								
2010	9,000	—	2,000	—	4,000	—	5,000	—
2020	10,000	10	3,000	35	5,000	8	6,000	11
2030	11,000	21	4,000	70	5,000	19	6,000	23
Kidney								
2010	48,000	—	29,000	—	18,000	—	30,000	—
2020	59,000	23	39,000	35	22,000	21	37,000	24
2030	69,000	44	48,000	67	25,000	42	44,000	45
Larynx								
2010	13,000	—	8,000	—	3,000	—	10,000	—
2020	16,000	25	11,000	37	3,000	21	13,000	26
2030	18,000	45	13,000	66	3,000	36	15,000	47
Leukemia								
2010	44,000	—	24,000	—	19,000	—	26,000	—
2020	53,000	21	31,000	33	22,000	18	31,000	22
2030	64,000	45	40,000	68	26,000	41	38,000	48
Liver								
2010	21,000	—	12,000	—	6,000	—	15,000	—
2020	27,000	28	17,000	42	8,000	28	19,000	28
2030	34,000	59	22,000	88	10,000	64	24,000	56
Lung								
2010	222,000	—	163,000	—	102,000	—	120,000	—
2020	280,000	26	218,000	34	126,000	23	155,000	29
2030	338,000	52	271,000	67	149,000	46	189,000	58

(continued on following page)

Table 1. Projected No. of Cancer Patients From 2010 Through 2030 by Age and Sex (continued)

	All		Age 65+		Women		Men	
Cancer Site and Year	No.	%*	No.	%*	No.	%*	No.	%*
Melanoma								
2010	70,000	—	34,000	—	29,000	—	41,000	—
2020	79,000	13	44,000	30	31,000	8	48,000	16
2030	87,000	25	52,000	54	34,000	17	53,000	30
Myeloma								
2010	20,000	—	13,000	—	9,000	—	11,000	—
2020	26,000	26	18,000	36	11,000	24	14,000	28
2030	32,000	57	24,000	77	14,000	53	18,000	59
Non-Hodgkin's lymphoma								
2010	67,000	—	39,000	—	31,000	—	36,000	—
2020	81,000	21	52,000	33	37,000	20	44,000	22
2030	97,000	44	65,000	67	44,000	43	53,000	46
Oral cavity and pharynx								
2010	37,000	—	19,000	—	11,000	—	25,000	—
2020	44,000	19	26,000	34	13,000	18	30,000	19
2030	49,000	35	31,000	61	15,000	36	34,000	34
Ovary								
2010	24,000	—	13,000	—	24,000	—	—	—
2020	28,000	17	17,000	31	28,000	17	—	—
2030	33,000	34	20,000	59	33,000	34	—	—
Pancreas								
2010	40,000	—	27,000	—	20,000	—	20,000	—
2020	50,000	25	36,000	34	25,000	23	25,000	27
2030	62,000	55	46,000	73	31,000	53	31,000	57
Prostate								
2010	246,000	—	182,000	—	—	—	246,000	—
2020	322,000	30	252,000	39	—	—	322,000	30
2030	382,000	55	310,000	71	—	—	382,000	55
Stomach								
2010	25,000	—	16,000	—	10,000	—	16,000	—
2020	33,000	29	22,000	39	12,000	26	20,000	31
2030	42,000	67	30,000	88	16,000	65	26,000	69
Testis								
2010	9,000	—	300	—	—	—	9,000	—
2020	9,000	3	400	34	—	—	9,000	3
2030	9,000	7	500	53	—	—	9,000	7
Thyroid								
2010	31,000	—	9,000	—	23,000	—	8,000	—
2020	35,000	11	12,000	35	26,000	10	9,000	14
2030	38,000	20	14,000	59	28,000	19	10,000	25
Uterus								
2010	44,000	—	24,000	—	44,000	—	—	—
2020	52,000	19	32,000	32	52,000	19	—	—
2030	58,000	32	38,000	56	58,000	32	—	—

NOTE. Projected patients numbers are rounded to the nearest 1,000, except projections < 1,000 which are rounded to the nearest 100.
*Percent change from 2010 (calculated using unrounded incidence projections).

premalignant lesions such as colonic polyps.[22] Finally, to counter the rising costs of cancer care, oncology-oriented residency and fellowship programs should emphasize training in the cost-effective use of medical resources, and phase III cancer clinical trials should begin to include cost-effectiveness analysis as an important end point.

To address the anticipated surge in cancer incidence specifically in older adults, significant research investments are needed. Growing evidence from diverse cancers such as glioblastoma,[23] prostate cancer,[24] endometrial cancer,[25] breast cancer,[26] and acute myelogenous leukemia[27] suggests that age at diagnosis is a critical factor modifying both cancer biology and response to therapy. Therefore, randomized clinical trials and nonrandomized clinical studies are urgently needed to identify clinically beneficial, cost-effective treatment strategies tailored to older adults. Since chronological age is a poor descriptor of functional age, future studies in geriatric populations should explore factors other than chronological age, such as comorbidity, functional and nutritional status, cognitive functioning, and social support.[28] Such studies could ultimately lead to evidence-based clinical guidelines that will help cancer physicians as they adapt their therapies to the unique functional and physiologic limitations of their older patients.

The anticipated marked increase in cancer among minorities is also particularly important for several reasons. In addition to race-based disparities in care patterns and outcomes as discussed earlier, the marked increase in cancer among Asian/Pacific Islanders and Hispanics creates the unique challenge of treating difficult malignancies, such as stomach and liver cancer, that are relatively more common in these racial/ethnic groups, in addition to the complexity of providing culturally competent communication to individuals from different backgrounds. Looking to the future, a high priority should be placed not only on addressing disparities in cancer care, but also on increasing recruitment of minorities to cancer clinical trials,[14] in order to improve understanding of race-based differences in cancer biology,[29] effectiveness of cancer therapy,[30] and normal tissue response to cancer therapy.[31]

The projections in this study are based on the assumption that age-, sex-, race-, and origin-specific cancer incidence rates will remain relatively constant over time. Although this assumption appears reasonable based on historical data as presented in Figure 1, it is likely that continued efforts to promote cancer prevention and risk factor modification, such smoking cessation[32] or decreased use of hormone replacement therapy,[33] will exert a downward pressure on cancer incidence in the future, though precise quantification of these effects is elusive. Therefore, it is important to underscore that these projections are subject to change as both society and medicine evolve, and will need to be periodically reevaluated. Nevertheless, because physician training and clinical trials often require 10 or more years to complete, the 20-year projections presented in this article are needed, as they will serve to inform current health policy and research priorities.

The number of cancer cases, particularly in older and minority individuals, is expected to vastly increase over the next two decades. Consequently, resources needed for cancer prevention, screening, detection, and treatment will need to increase concomitantly. Optimal cancer treatments for older and minority patients remain to be defined, and design of future clinical trials should consider these impending changes. Within a broader perspective, renewed governmental interest in health care reform should include a substantial focus on the elderly, minorities, and the medically underserved in order to address structural causes of unequal cancer care and to promote development of the national health care infrastructure needed to provide skilled and timely cancer care to even the most vulnerable segments of our population.

AUTHORS' DISCLOSURES OF POTENTIAL CONFLICTS OF INTEREST

The author(s) indicated no potential conflicts of interest.

AUTHOR CONTRIBUTIONS

Conception and design: Benjamin D. Smith, Grace L. Smith, Arti Hurria, Gabriel N. Hortobagyi, Thomas A. Buchholz
Administrative support: Benjamin D. Smith
Provision of study materials or patients: Benjamin D. Smith
Collection and assembly of data: Benjamin D. Smith
Data analysis and interpretation: Benjamin D. Smith, Grace L. Smith, Thomas A. Buchholz
Manuscript writing: Benjamin D. Smith, Grace L. Smith, Arti Hurria, Gabriel N. Hortobagyi, Thomas A. Buchholz
Final approval of manuscript: Benjamin D. Smith, Grace L. Smith, Arti Hurria, Gabriel N. Hortobagyi, Thomas A. Buchholz

REFERENCES

1. Census of Population: 1980 Census. http://www.census.gov/prod/www/abs/decennial/1980cenpopv1.htm

2. United States Census Bureau: 2008 National Population Projections. http://www.census.gov/population/www/projections/

3. US Census Bureau: 1990 Census. http://factfinder.census.gov/servlet/DatasetMainPageServlet?_lang=en&_ts=246063658125&_ds_name=DEC_1990_STF1_&_program=

4. Erikson C, Salsberg E, Forte G, et al: Future supply and demand for oncologists: Challenges to assuring access to oncology services. J Oncol Practice 3:79-86, 2007

5. Ries LAG, Melbert D, Krapcho M, et al: SEER Cancer Statistics Review, 1975-2005. Bethesda, MD, National Cancer Institute, 2008. http://seer.cancer.gov/csr/1975_2005/

6. Hutchins LF, Unger JM, Crowley JJ, et al: Underrepresentation of patients 65 years of age or older in cancer-treatment trials. N Engl J Med 341:2061-2067, 1999

7. Bouchardy C, Rapiti E, Blagojevic S, et al: Older female cancer patients: Importance, causes, and consequences of undertreatment. J Clin Oncol 25:1858-1869, 2007

8. Gross CP, Smith BD, Wolf E, et al: Racial disparities in cancer therapy: Did the gap narrow between 1992 and 2002? Cancer 112:900-908, 2008

9. Surveillance, Epidemiology, and End Results (SEER) Program. (www.seer.cancer.gov) SEER*Stat Database: Incidence - SEER 17 Regs Limited-Use + Hurricane Katrina Impacted Louisiana Cases, Nov 2007 Sub (2000-2005) <Katrina/Rita Population Adjustment> - Linked To County Attributes - Total US, 1969-2005 Counties, National Cancer Institute, DCCPS, Surveillance Research Program, Cancer Statistics Branch

10. Cancer Query Systems: Delay-Adjusted SEER Incidence Rates. http://srab.cancer.gov/delay/canques.html

11. Clegg LX, Feuer EJ, Midthune DN, et al: Impact of reporting delay and reporting error on cancer incidence rates and trends. J Natl Cancer Inst 94:1537-1545, 2002

12. Jemal A, Siegel R, Ward E, et al: Cancer statistics, 2008. CA Cancer J Clin 58:71-96, 2008

13. Haynes MA, Smedley BD: Underserved CoCRaMatM: The Unequal Burden of Cancer: An Assessment of NIH Research and Programs for Ethnic Minorities and the Medically Underserved. Washington, DC, The National Academies Press, 1999

14. Murthy VH, Krumholz HM, Gross CP: Participation in cancer clinical trials: Race-, sex-, and age-based disparities. JAMA 291:2720-2726, 2004

15. Hurria A, Balducci L, Naeim A, et al: Mentoring junior faculty in geriatric oncology: Report from the Cancer and Aging Research Group. J Clin Oncol 26:3125-3127, 2008

16. Freund KM, Battaglia TA, Calhoun E, et al: National Cancer Institute Patient Navigation Program: Methods, protocols, and measures. Cancer 113:3391-3399, 2008

17. Hortobagyi GN: A shortage of oncologists? The American Society of Clinical Oncology workforce study. J Clin Oncol 25:1468-1469, 2007

18. Services CotFHCWfOABoHC: Retooling for an aging America: Building the Health Care Workforce, in Haynes MA, Smedley BD (eds). Washington, DC, National Academies Press, 2008

19. Warren JL, Yabroff KR, Meekins A, et al: Evaluation of trends in the cost of initial cancer treatment. J Natl Cancer Inst 100:888-897, 2008

20. American Association of Medical Colleges: Workforce statement. http://www.aamc.org/workforce/

21. Dunne EF, Datta SD, E Markowitz L: A review of prophylactic human papillomavirus vaccines: Recommendations and monitoring in the US. Cancer 113:2995-3003, 2008

22. Greenwald P: Cancer prevention clinical trials. J Clin Oncol 20:14S-22S, 2002

23. Gorlia T, van den Bent MJ, Hegi ME, et al: Nomograms for predicting survival of patients with newly diagnosed glioblastoma: Prognostic factor analysis of EORTC and NCIC trial 26981-22981/CE.3. Lancet Oncol 9:29-38, 2008

24. Bill-Axelson A, Holmberg L, Ruutu M, et al: Radical prostatectomy versus watchful waiting in early prostate cancer. N Engl J Med 352:1977-1984, 2005

25. Creutzberg CL, van Putten WL, Koper PC, et al: Surgery and postoperative radiotherapy versus surgery alone for patients with stage-1 endometrial

carcinoma: Multicentre randomised trial. PORTEC Study Group. Lancet 355:1404-1411, 2000

26. Bartelink H, Horiot JC, Poortmans P, et al: Recurrence rates after treatment of breast cancer with standard radiotherapy with or without additional radiation. N Engl J Med 345:1378-1387, 2001

27. Dombret H, Raffoux E, Gardin C: Acute myeloid leukemia in the elderly. Semin Oncol 35:430-438, 2008

28. Yancik R, Wesley MN, Ries LA, et al: Effect of age and comorbidity in postmenopausal breast cancer patients aged 55 years and older. JAMA 285: 885-892, 2001

29. Carey LA, Perou CM, Livasy CA, et al: Race, breast cancer subtypes, and survival in the Carolina Breast Cancer Study. JAMA 295:2492-2502, 2006

30. Polite BN, Cirrincione C, Fleming GF, et al: Racial differences in clinical outcomes from metastatic breast cancer: A pooled analysis of CALGB 9342 and 9840–Cancer and Leukemia Group B. J Clin Oncol 26:2659-2665, 2008

31. Tuamokumo NL, Haffty BG: Clinical outcome and cosmesis in African-American patients treated with conservative surgery and radiation therapy. Cancer J 9:313-320, 2003

32. Jemal A, Thun MJ, Ries LA, et al: Annual report to the nation on the status of cancer, 1975-2005, featuring trends in lung cancer, tobacco use, and tobacco control. J Natl Cancer Inst 100:1672-1694, 2008

33. Ravdin PM, Cronin KA, Howlader N, et al: The decrease in breast-cancer incidence in 2003 in the United States. N Engl J Med 356:1670-1674, 2007

