
Prostate Cancer

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Purpose: We quantified the burden of prostate cancer in the United States by identifying trends in incidence, disease presentation, survival rates and use of health care resources, and by estimating the economic impact of the disease.

Materials and Methods: The analytic methods used to generate these results were described previously.

Results: Age adjusted prostate cancer incidence rates peaked in 1992 at 237/100,000 men, decreased in 1995 and then increased at approximately 1.7% yearly through 2000, when the rate was 180/100,000. Marked stage migration and an improvement in 5-year overall survival were also noted. Age adjusted inpatient hospitalizations for prostate cancer decreased in the 1990s from 729/100,000 population in 1992 to 309/100,000 in 2001. Considerable ethnic and regional variation was noted. During the same period age adjusted radical prostatectomy rates varied from 128/100,000 men in 1994 to 108/100,000 in 2000. Surgery rates decreased in older men, while they increased in younger men. Outpatient physician office visits also varied in the 1990s with ethnic and regional variation again noted. Finally, the total medical expenditure for prostate cancer treatment was \$1.3 billion in 2000, which represents a 30% increase over the total expenditure for 1994.

Conclusions: The burden of prostate cancer in the United States is considerable and it appears to have markedly increased in the prostate specific antigen era. Further research is needed to determine if we are using our limited health care resources appropriately for the diagnosis and treatment of this common malignancy.

Key Words: prostate, prostatic neoplasms, health care costs, health services research, cost and cost analysis

One of approximately every 6 American men older than 50 years is diagnosed with prostate cancer in his lifetime.¹ This astonishing statistic underscores the significance of this cancer, not only as a urological disease, but also as a general public health burden. It should be noted that the lifetime risk of prostate cancer has increased considerably in the last 15 years following the introduction of PSA testing. Although the risk of being diagnosed with prostate cancer is high, the risk of dying of the disease is much lower, in that about 1 of every 33 American men older than 50 years actually dies of prostate cancer.² In this respect there is truth in the clinical adage that more men die with prostate cancer than of it. While the mortality burden associated with prostate cancer is less than might be expected, the physical, psychological and economic burdens are considerable. To improve our understanding of the public health impact of this malignancy we explored the burden of prostate cancer in the United States by 1) quantifying and identifying trends in disease incidence, presentation and survival, 2) examining changing use rates of health care resources and 3) assessing the economic impact of this disease.

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MATERIALS AND METHODS

The analytical methods used to generate these results were described previously.³

RESULTS

Incidence, Presentation and Survival

Data from the National Cancer Institute SEER program were used to explore recent trends in prostate cancer incidence, disease presentation and survival in the United States. These results reflect the increasing use of serum based PSA testing, which began in the late 1980s and early 1990s. Incidence rates peaked in 1992 at 237/100,000 population (age adjusted, and all races and ages), decreased steeply until 1995 and then increased at approximately 1.7% yearly through 2000 (table 1). In 2000, 2001 and 2002 the annual age adjusted incidence rates were 180/100,000, 181/100,000 and 176/100,000 population, respectively.

Stage at diagnosis also changed dramatically in the last 20 years (table 2). During 1973 to 1979 and 1985 to 1989, 73% of prostate cancer diagnoses were localized or regional. In contrast, during 1995 to 2001, 91% of diagnoses were localized or regional. Across the same 3 intervals, the percent of patients with distant disease at diagnosis decreased from 20% to 16% to 5%, respectively.

Finally, these changes in incidence and stage at presentation were accompanied by changes in survival rates. Of white men 63% and 55% of black men diagnosed with prostate cancer in 1973 survived 5 years (table 3). For

TABLE 1. Incidence rates for prostate cancer by race/ethnicity and age

Diagnosis Yr	All Males			White Males			Black Males		
	All	Younger Than 65	65 or Older	All	Younger Than 65	65 or Older	All	Younger Than 65	65 or Older
1975	94.0	13.7	649.5	92.2	13.0	639.7	141.1	27.1	929.2
1976	97.9	14.6	674.1	97.3	13.9	674.0	140.8	29.4	910.9
1977	100.4	15.0	690.8	98.5	14.3	680.6	159.2	29.2	1,057.2
1978	99.4	15.2	681.2	97.7	14.8	671.2	148.0	26.8	985.3
1979	103.4	14.9	714.9	102.3	14.6	708.1	162.0	26.4	1,100.0
1980	105.9	15.4	730.9	104.8	14.6	728.2	160.9	33.6	1,040.3
1981	108.8	16.8	745.1	107.9	16.0	743.1	161.6	34.2	1,041.9
1982	108.2	16.3	743.2	107.3	15.8	739.9	167.8	31.5	1,109.8
1983	111.6	17.1	764.2	110.7	16.6	761.6	170.9	34.1	1,116.8
1984	111.6	17.2	763.8	110.0	16.2	758.2	178.9	37.3	1,158.1
1985	115.4	17.9	790.0	114.6	17.5	785.2	169.8	31.5	1,125.8
1986	118.9	18.5	813.2	118.9	18.2	814.9	167.7	33.8	1,093.3
1987	133.5	21.5	908.1	134.3	21.1	917.4	188.9	36.2	1,244.4
1988	137.4	22.2	934.1	138.5	22.3	941.6	190.5	34.8	1,267.1
1989	145.3	24.1	982.7	146.0	24.0	989.4	191.8	37.1	1,260.8
1990	170.7	28.7	1,152.2	172.4	28.7	1,165.3	221.9	44.4	1,448.8
1991	214.5	38.8	1,429.3	216.1	39.2	1,439.1	287.9	57.2	1,882.7
1992	237.0	49.3	1,534.5	237.7	49.3	1,539.5	326.5	77.1	2,050.6
1993	209.2	50.5	1,306.1	204.0	49.0	1,275.4	342.4	93.5	2,063.3
1994	179.9	48.5	1,088.4	173.7	46.7	1,052.0	310.7	94.4	1,805.8
1995	168.5	49.8	988.7	163.4	48.0	961.3	278.5	97.3	1,531.1
1996	168.3	53.1	964.5	163.6	51.6	938.0	279.7	99.3	1,526.1
1997	172.5	55.0	984.7	168.5	53.7	961.8	278.1	96.0	1,536.8
1998	169.4	54.5	963.7	165.4	52.6	945.5	279.9	100.7	1,519.2
1999	181.3	60.5	1,016.7	176.0	58.4	988.8	285.5	109.9	1,499.2
2000	179.9	61.2	1,000.6	175.8	59.2	981.8	284.2	111.5	1,478.0
2001	180.8	63.4	992.7	178.2	61.2	986.7	260.6	111.5	1,290.7
2002	176.3	63.8	953.9	171.9	61.5	935.4	275.8	113.7	1,396.1

Rates per 100,000 age adjusted to the 2000 United States standard population (source: SEER Program [www.seer.cancer.gov] Public Use Data, 1973 to 2002, National Cancer Institute, DCCPS, Surveillance Research Program, Cancer Statistics Branch, released April 2005, based on the November 2004 submission).

men diagnosed in 1981 survival rates increased to approximately 75% and 65% for white and black men, and for 1995 to 2000 this increased again to 100% and 96% for white and black men, respectively. Of all men essentially 100% survived 5 years or more during this more recent period if they were initially diagnosed with local/regional disease.

Health Care Resource Use

Inpatient care. The inpatient care of patients with prostate cancer often includes primary surgery (radical prostatectomy) for localized disease, management of complications

of tumor or its treatment, delivery of certain forms of chemotherapy and end of life care in patients with advanced disease. Therefore, one would expect to see changes in inpatient care in the 1990s that reflected increased PSA screening and movement of care previously delivered in the inpatient setting to outpatient facilities. This is in fact what was observed.

Table 4 shows the total number of inpatient stays by male Medicare beneficiaries with a primary diagnosis of prostate cancer during 1992 and 2001. Overall almost 86,000 men older than 65 years were hospitalized with a primary diagnosis of prostate cancer in 1992. In contrast, fewer than 36,000 men had hospital stays in 2001. The age adjusted rate of inpatient stays decreased from 729/100,000 to 309/100,000 population between 1992 and 2001. Table 4 also indicates that the inpatient hospitalization rate was greater for black than for white American men at all time points, possibly reflecting the increasing incidence of the disease in this racial group. Trends in geographic variation in inpatient use are also interesting. Although there was a marked decrease in inpatient hospitalization in all geographic regions, the decrease between 1992 and 2001 was most striking in the West and Northeast. The reasons for this are unclear but they may reflect geographic trends in screening and treatment practices during this period.

Data from the HCUP Nationwide Inpatient Sample indicated similar trends (table 5). Hospitalization rates for prostate cancer in rural regions were less than half the rates in urban areas during 1994 to 2000. There was also geographic variation with the West having the lowest hospitalization rates in the country.

TABLE 2. Stage distribution by race/ethnicity for patients with prostate cancer at all ages

	% All	% White	% Black
1975-1979:			
Localized	73	73	66
Regional	0	0	0
Distant	20	19	28
Unstaged	7	8	5
1985-1989:			
Localized	73	74	65
Regional	0	0	0
Distant	16	15	25
Unstaged	11	11	11
1995-2000:			
Localized	91	91	89
Regional	0	0	0
Distant	5	5	7
Unstaged	4	4	5

Source: SEER Program (www.seer.cancer.gov) SEER*Stat Database: Incidence-SEER 9 Regs Public Use, November 2004 Sub (1973 to 2002), National Cancer Institute, DCCPS, Surveillance Research Program, Cancer Statistics Branch, released April 2005, based on the November 2004 submission.

TABLE 3. Five-year survival rates for prostate cancer by race/ethnicity, diagnosis year, stage and age

	All Males			White Males			Black Males		
	All	Younger Than 50	50 or Older	All	Younger Than 50	50 or Older	All	Younger Than 50	50 or Older
Diagnosis yr:									
1960–1963	Not available	Not available	Not available	50.0	Not available	Not available	35.0	Not available	Not available
1970–1973	Not available	Not available	Not available	63.0	Not available	Not available	55.0	Not available	Not available
1974–1976	67.1	71.5	65.5	68.1	73.0	66.4	58.4	60.7	57.0
1977–1979	71.1	75.8	69.4	72.2	77.5	70.3	62.6	64.4	61.7
1980–1982	73.4	76.4	72.3	74.5	78.0	73.3	64.8	66.7	63.8
1983–1985	74.8	75.7	74.5	76.2	77.5	75.8	63.9	64.6	63.5
1986–1988	81.2	81.3	81.2	82.7	83.1	82.6	69.3	69.8	69.1
1989–1991	90.7	90.2	90.8	92.0	91.3	92.2	80.8	82.3	80.2
1992–1994	97.3	96.3	97.7	98.1	97.0	98.6	92.4	93.4	91.9
1995–2000	99.3*	99.1	99.7	100.0*	99.5	100.0	96.0*	98.1	95.1*
1995–2000:									
All stages	99.3	99.1	99.7	100.0	99.5	100.0	96.0		95.1
Localized/regional	100.0	100.0	100.0	100.0	100.0	100.0	100.0		100.0
Distant	33.5	30.5	34.6	32.7	30.3	33.6	29.0		28.0
Unstaged	81.4	89.3	79.4	82.8	91.3	80.9	75.5		72.4
Diagnosis age:									
Younger than 45	91.7	Not available	Not available	91.3	Not available	Not available	95.4	Not available	Not available
45–54	97.2	Not available	Not available	97.5	Not available	Not available	96.8	Not available	Not available
55–64	99.7	Not available	Not available	100.0	Not available	Not available	98.4	Not available	Not available
65–74	100.0	Not available	Not available	100.0	Not available	Not available	98.1	Not available	Not available
75 or Older	94.8	Not available	Not available	96.5	Not available	Not available	87.5	Not available	Not available
Younger than 65	99.1	Not available	Not available	99.5	Not available	Not available	98.1	Not available	Not available
65 or Older	99.7	Not available	Not available	100.0	Not available	Not available	95.1	Not available	Not available

Rates for 1960 to 1973 based on End Results data from a series of hospital registries and 1 population based registry, and rates for 1974 to 2000 from SEER 9 areas, based on data from population based registries in Connecticut, Puerto Rico, Utah, Iowa, Hawaii, Atlanta, Detroit, Seattle-Puget Sound and San Francisco-Oakland, and based on followup of patients into 2001 (survival rate SE of 5% to 10%) (source: SEER Program [www.seer.cancer.gov] SEER*Stat Database: Incidence-SEER 9 Regs Public Use, submission November 2004 Sub (1973 to 2002), National Cancer Institute, DCCPS, Surveillance Research Program, Cancer Statistics Branch, released April 2005, based on the November 2004 submission).

* Statistically significant difference vs 1974 to 1976 (p < 0.05).

It is likely that changes in inpatient prostate cancer care were related at least in part to radical prostatectomy use rates. To explore this hypothesis HCUP data were used to examine trends in radical prostatectomy. Radical prostatectomy rates were relatively stable in 1994 and 1996 (128/100,000 and 127/100,000 men older than 40 years, respectively) but rates decreased in 1998 to 99/100,000 and then increased again in 2000 to 108/100,000 (table 6). Importantly when prostatectomy rates were stratified by age, rates decreased consistently in patients older than 65 years, while there were consistent increases in the rates for patients 40 to 54 years old. Briefly, there were significant changes in the use of radical prostatectomy in the last 15 years with the overall rate of use decreasing in older men but increasing in younger men. This likely influenced trends in inpatient prostate cancer care.

Outpatient care. Although the inpatient component of care is important, most prostate cancer survivors receive a significant portion of their care as outpatients. We focused on a single aspect of outpatient care, that is physician office visits. NAMCS data documented that the average annual age adjusted rate of physician office visits for prostate cancer in 1992 to 2000 was 5,001/100,000 American males older than 40 years (table 7). The rate was 5,449/100,000 in 1992 and it decreased to a low of 3,870/100,000 in 1998. It then increased to 5,828/100,000 in 2000. The exact reasons for these shifts are unclear. In this period men 75 to 84 years old had the highest rate of office visits compared with that in men 65 to 74 and 40 to 64 years old (112,069/100,000 vs 54,445/100,000 and 5,930/100,000, respectively). This may be explained by the fact that older patients are least likely to undergo aggres-

sive therapy for localized disease and most likely to elect conservative management. Therefore, they may be seen more often by their providers and may require more outpatient care.

Data from the Medicare sample did not show the same decrease between 1992 and 1998. Rather, they indicated that the rate of physician office visits increased from 1992 to 1995 and remained relatively stable after that, reflecting changes in the age adjusted incidence rate of prostate cancer (table 8). Differences between NAMCS and Medicare data may be explained by the fact that Medicare patients were older and likely had somewhat different patterns of care than the younger patients in the NAMCS sample. There was considerable geographic variation in physician office visit rates in the NAMCS and Medicare samples, although the differences were not consistent between the 2 data sets. It is likely that physician office visits were related to patterns of care in primary treatment choice. The relation of primary treatment to geographic region and patient age would explain the differing patterns of geographic variation between the 2 samples.

Economic Impact

Medical expenditures for prostate cancer treatment in the United States totaled \$1.3 billion in 2000, almost 30% more than in 1994 (table 9). The growth in spending occurred despite a decrease in hospitalization costs as treatment shifted from inpatient to outpatient settings. Spending on treatment provided in physician offices more than tripled between 1994 and 2000, while expenditures for ambulatory surgery more than doubled during this period. By 2000

TABLE 4. *Inpatient hospital stays by male Medicare beneficiaries with prostate cancer listed as primary diagnosis*

	1992			1995			1998			2001		
	Count	Rate (95% CI)	Age Adjusted Rate	Count	Rate (95% CI)	Age Adjusted Rate	Count	Rate (95% CI)	Age Adjusted Rate	Count	Rate (95% CI)	Age Adjusted Rate
Total all ages	87,540	588 (570–605)		50,620	333 (320–346)		38,840	268 (256–280)		37,840	245 (234–256)	
Total younger than 65	1,720	55 (43–67)		1,740	51 (40–61)		1,460	42 (33–52)		1,860	49 (39–59)	
Total 65 or older	85,820	729 (707–751)	729	48,880	415 (399–432)	410	37,380	339 (323–354)	337	35,980	310 (295–324)	309
Age:												
65–69	27,620	679 (643–714)		17,260	448 (418–478)		12,680	376 (346–405)		12,340	349 (321–376)	
70–74	27,720	853 (808–897)		15,240	457 (425–489)		11,500	377 (346–408)		10,520	342 (313–371)	
75–79	16,580	732 (683–782)		7,360	324 (291–358)		5,700	250 (221–279)		5,820	237 (210–264)	
80–84	8,720	666 (603–728)		5,300	381 (336–427)		3,800	276 (237–315)		3,540	237 (202–271)	
85–89	3,780	634 (544–724)		2,340	367 (301–434)		2,580	397 (328–465)		2,500	346 (285–406)	
90–94	1,200	592 (443–742)		1,060	501 (367–636)		920	428 (304–551)		1,040	449 (327–571)	
95–97	160	396 (121–671)		200	531 (202–859)		180	455 (159–750)		140	364 (94–635)	
98 or Older	40	105 (0.0–250)		120	271 (54–488)		20	42 (0.0–123)		80	147 (3.7–291)	
Race/ethnicity:												
White	74,280	591 (572–610)	592	42,800	329 (315–343)	330	32,200	263 (250–276)	263	31,400	240 (228–252)	240
Black	8,600	674 (611–737)	646	5,860	423 (375–472)	412	4,880	366 (320–411)	355	4,880	319 (278–360)	315
Asian	Not available	Not available	Not available	100	137 (16–258)	137	160	117 (36–198)	131	140	68 (18–119)	68
Hispanic	Not available	Not available	Not available	560	282 (178–386)	282	740	220 (150–291)	215	640	170 (111–229)	160
North American native	Not available	Not available	Not available	40	199 (0.0–472)	298	60	215 (0.0–458)	143	100	300 (36–565)	240
Region:												
Midwest	20,840	562 (528–596)	566	11,700	304 (279–328)	300	10,220	276 (252–300)	279	9,620	253 (231–276)	259
Northeast	18,620	587 (550–625)	573	11,760	370 (340–400)	360	7,420	267 (240–294)	270	6,720	230 (205–255)	221
South	32,260	616 (586–646)	616	19,360	353 (331–375)	357	14,960	279 (259–299)	277	15,180	261 (243–280)	262
West	14,720	609 (566–653)	622	7,200	310 (278–343)	322	5,700	255 (225–284)	251	5,660	229 (202–255)	231

Unweighted counts multiplied by 20 to arrive at values, rate per 100,000 male Medicare beneficiaries in the same demographic stratum, age adjusted rates adjusted to the 2000 United States Census and individuals of other races, unknown race and ethnicity, and other region included in the total (counts less than 600 should be interpreted with caution) (source: Centers for Medicare and Medicaid Services, Medicare Provider Analysis and Review Files, 1992, 1995, 1998 and 2001).

TABLE 5. *Inpatient hospital stays for prostate cancer as primary diagnosis for 1994 to 2000 (merged)*

	1994–2000		
	Count	4-Yr Rate (95% CI)	Av Annualized Rate/yr
Totals	407,042	815 (780–851)	204
Age:			
40–44	1,651	16 (13–19)	4.0
45–54	33,749	211 (189–234)	53
55–64	118,051	1,143 (1,064–1,223)	286
65–74	161,183	2,006 (1,929–2,084)	502
75–84	69,400	1,598 (1,544–1,652)	400
85 or Older	23,009	2,441 (2,338–2,544)	610
Race/ethnicity:			
White	260,321	651 (614–687)	163
Black	37,954	821 (769–872)	205
Hispanic	14,584	412 (368–456)	103
Region:			
Midwest	96,752	827 (766–887)	207
Northeast	89,190	887 (817–956)	222
South	148,779	851 (772–929)	213
West	72,322	677 (626–728)	169
MSA:			
Urban	352,310	939 (893–985)	235
Rural	53,269	429 (397–461)	107

Rate per 100,000 based on 1994, 1996, 1998 and 2000 population estimates from CPS, CPS Utilities, Unicon Research Corp. for relevant demographic categories of adult male civilian noninstitutionalized population 40 years or older in the United States with individuals of other races and with missing or unavailable race and ethnicity, and missing MSA included in the total (counts may not sum to total due to rounding) (source: HCUP Nationwide Inpatient Sample, 1994, 1996, 1998 and 2000).

inpatient expenditures accounted for 48% of total spending on prostate cancer, down from 69% in 1994.

Because prostate cancer primarily affects older males, more than two-thirds of all spending for the condition was borne by the Medicare program. Medicare reimbursements for prostate cancer totaled \$846 million in 1992 and \$927 million in 2001 (table 10). Medicare spending among beneficiaries younger than 65 years increased from \$16 million in 1992 to more than \$38 million in 2001, largely due to increased screening.

Individual level expenditures were estimated using risk adjusted regression models controlling for age, work status, geographic location and health plan characteristics. For males 40 to 64 years old with employer provided insurance average annual expenditures for prostate cancer totaled \$11,445 compared with \$4,426 for similar men without the condition (table 11). This suggests that the annual incremental costs associated with prostate cancer exceeded \$7,000 per individual. Average spending was higher for men 40 to 54 years and in the West, although regional variation was modest.

DISCUSSION

Prostate cancer is the most common urological malignancy and the most common solid cancer found in American men. Disease incidence, stage at presentation and 5-year survival rates changed dramatically in the last 20 years following the introduction of PSA testing, which resulted in widespread screening for this cancer throughout the United States and Western Europe. Our data demonstrate that short-term survival rates improved in the PSA era. Others documented that overall long-term mortality⁴ and disease specific mortality rates⁵ also appeared to be decreasing in the PSA era.

It was speculated that these decreases reflect the beneficial effects of early diagnosis with PSA screening or improved treatments. However, it was also noted that decreases in mortality may be attributable to other causes, such as earlier and widespread use of androgen deprivation therapy. Specifically Lu-Yao et al compared prostate cancer specific mortality between 2 population based cohorts of men with prostate cancer from King County, Washington and Connecticut.⁶ Although PSA use rates and treatment patterns differed widely between the 2 populations, prostate cancer mortality was comparable, implying that more intensive screening was not associated with the decrease in mortality. Formal, randomized, clinical trial data on PSA screening in the general population are anticipated from the European Randomized Screening for Prostate Cancer Trial, and the Prostate, Lung, Colorectal and Ovary cancer trial within the next several years. These data should provide a better understanding of the value of prostate cancer screening for decreasing mortality. However, in the meantime prostate cancer screening has been embraced by the clinical community and the general population, and it likely will continue to be widely used.

Patterns of care also changed tremendously in the last 20 years. Some of these changes were directly related to the introduction of PSA testing, while others reflect improved understanding of prostate cancer by clinicians and researchers. In particular older men with shorter life expectancies are on average receiving less aggressive therapy than in the past, reflecting the clinician realization that older men are at decreased risk for prostate cancer mortality due to competing comorbid diseases. For example, Bubolz et al reviewed the Medicare part A data set for 1993 to 1997 and documented that external beam radiotherapy rates were relatively stable for all patients except those older than 75 years.⁷ In older patients external beam radiotherapy use decreased, reflecting the general realization by providers that many of these patients did not require any treatment, given their relatively short life expectancy and comorbid conditions.

In contrast, our data and those of others⁸ showed that more men are being diagnosed at younger ages and with earlier stage disease. Therefore, they are undergoing more aggressive therapies for the condition. Surgical rates have consistently increased in these younger patients. There is considerable racial and geographic variation in treatment use, although this is probably the result of clinical uncertainty as to which treatment is best for men with localized prostate cancer. Additional level I clinical trial data are desperately needed to identify which patients are best served by which therapies. Although there is a single randomized clinical trial documenting that surgery is superior to active surveillance for overall survival when patients are followed for a long enough period,⁹ there are no adequately sized clinical trials comparing active therapies to each other in terms of survival. Until these studies are completed there will be continued ethnic and regional variations in practice patterns and the quality of prostate cancer care will be suboptimal.

Finally, data from the current analyses document that there is a tremendous economic burden associated with the diagnosis and treatment of prostate cancer in the United States. It should be noted that the dollar figures presented still do not capture all of the costs of this common disease.

TABLE 6. Radical prostatectomy in men hospitalized for primary diagnosis of prostate cancer

	1994			1996			1998			Count	Rate/100,000 Population (95% CI)
	Count	Rate/100,000 Population (95% CI)	Rate/100,000 Hospitalizations for Primary Prostate Ca Diagnosis (95% CI)	Count	Rate/100,000 Population (95% CI)	Rate/100,000 Hospitalizations for Primary Prostate Ca Diagnosis (95% CI)	Count	Rate/100,000 Population (95% CI)	Rate/100,000 Hospitalizations for Primary Prostate Ca Diagnosis (95% CI)		
Totals	58,254	128 (128–128)	50,553 (50,440–50,666)	61,952	127 (126–127)	57,851 (57,710–57,992)	50,943	99 (99–99)	57,861 (57,744–57,978)	58,191	108 (108–108)
Age:*											
40–54	5,467	23 (23–24)	4,744 (4,721–4,768)	7,573	29 (29–30)	7,072 (7,039–7,104)	7,439	27 (27–27)	8,449 (8,416–8,483)	10,198	35 (35–35)
55–64	22,683	236 (235–237)	19,684 (19,621–19,749)	25,288	254 (254–255)	23,614 (23,552–23,676)	21,267	201 (200–201)	24,155 (24,090–24,218)	26,135	234 (234–235)
65–74	28,444	361 (360–362)	24,684 (24,612–24,756)	27,861	341 (340–342)	26,017 (25,938–26,095)	21,161	263 (262–264)	24,034 (23,959–24,109)	20,815	259 (258–260)
75–84	1,649	43 (42–45)	1,431 (1,395–1,467)	1,220	29 (28–30)	1,139 (1,086–1,193)	1,076	24 (23–25)	1,222 (1,176–1,270)	1,026	21 (20–22)
Race/ethnicity:			34,196 (34,103–34,288)								
White	39,405	107 (106–107)	3,660 (3,640–3,680)	42,773	108 (108–109)	39,942 (39,828–40,056)	32,845	80 (80–81)	37,305 (37,211–37,399)	35,009	82 (82–82)
Black	4,218	102 (102–103)	1,327 (1,313–1,342)	5,188	116 (116–116)	4,845 (4,832–4,857)	4,307	90 (89–90)	4,892 (4,859–4,925)	4,784	94 (93–94)
Hispanic	1,529	50 (50–51)		1,626	50 (49–50)	1,518 (1,503–1,533)	2,117	55 (55–56)	2,404 (2,383–2,426)	2,210	55 (54–55)
Region:			8,059 (8,014–8,104)								
Northeast	9,287	96 (95–96)	12,294 (12,233–12,357)	12,237	124 (124–125)	11,427 (11,384–11,470)	10,994	108 (107–108)	12,487 (12,427–12,548)	12,924	123 (123–124)
Midwest	14,167	133 (132–134)	20,401 (20,317–20,485)	16,212	139 (138–139)	15,139 (15,092–15,187)	11,749	99 (98–99)	13,344 (13,285–13,403)	13,853	110 (110–111)
South	23,509	153 (152–153)	9,798 (9,766–9,831)	23,450	137 (136–137)	21,698 (21,793–22,002)	17,307	95 (95–95)	19,657 (19,582–19,731)	20,758	108 (108–108)
West	11,291	116 (115–116)		10,052	98 (98–99)	9,387 (9,317–9,458)	10,893	98 (97–98)	12,372 (12,337–12,408)	10,657	92 (92–92)
MSA:											
Rural	6,255	50 (50–51)	5,428 (5,401–5,456)	5,898	50 (49–50)	5,508 (5,455–5,559)	5,183	42 (42–42)	5,887 (5,855–5,919)	5,888	45 (45–48)
Urban	51,768	157 (156–157)	44,924 (44,814–45,034)	55,883	151 (151–151)	52,184 (52,054–52,314)	45,599	117 (116–117)	51,791 (51,678–51,904)	52,245	128 (127–128)

Rate per 100,000 based on 1994 to 2000 population estimates from CPS, CPS Utilities, Unicon Research Corp. for relevant demographic categories of adult male civilian noninstitutionalized population 40 years or older in the United States, rate per 100,000 male 40 years or older visits with radical prostatectomy performed based on estimated number of visits for prostate cancer in HCUP National Inpatient Sample, 1994 to 2000 and individuals of other races, and with missing or unavailable race and ethnicity, and missing MSA included in the total (counts may not sum to total due to rounding) (source: HCUP Nationwide Inpatient Sample, 1994, 1996, 1998 and 2000).

* Values for ages 85 years or older do not meet reliability or precision standard.

TABLE 7. Physician office visits for prostate cancer as primary diagnosis

	1992–2000				1992			1994			
	Count	Rate	Av Annualized Rate/Yr	Age Adjusted Rate	Count	Rate	Age Adjusted Rate	Count	Rate	Age Adjusted Rate	Count
Totals	12,236,564	25,004 (22,810–27,198)	5,001	25,034	2,450,034	5,449 (4,410–6,487)	5,449	2,234,586	4,910 (4,112–5,709)	4,910	2,420,055
Age:											
40–64	2,118,240	5,930 (4,647–7,212)	1,186		*	*		301,211	914 (515–1,314)		*
65–74	4,399,702	54,445 (46,664–62,226)	10,889		832,868	10,070 (6,717–13,423)		783,398	9,946 (7,212–12,681)		964,667
75–84	4,739,092	112,069 (95,718–128,421)	22,414		1,007,893	26,753 (18,874–34,632)		993,754	26,205 (19,613–32,796)		826,418
85 or Older	979,530	108,031 (79,820–136,242)	21,606		*	*		*	*		*
Race/ethnicity:											
White	10,498,163	26,644 (24,119–29,170)	5,329	25,313	2,217,258	5,998 (4,799–7,197)	5,730	1,893,654	5,120 (4,222–6,018)	4,881	2,159,471
Other	1,738,401	18,227 (14,001–22,452)	3,645	23,366	*	*	*	340,932	4,000 (2,270–5,730)	5,109	*
Region:											
Midwest	2,906,931	25,262 (20,840–29,683)	5,052	25,086	*	*	*	595,052	5,590 (3,971–7,209)	5,649	520,291
Northeast	3,718,177	37,425 (31,362–43,488)	7,485	36,556	817,237	8,649 (6,016–11,282)	8,360	695,338	7,164 (4,685–9,643)	7,018	665,572
South	3,187,693	18,669 (15,599–21,740)	3,734	18,435	647,909	4,207 (2,690–5,723)	4,139	595,211	3,868 (2,760–4,976)	3,868	670,950
West	2,423,763	23,256 (18,398–28,114)	4,651	24,738	614,662	6,544 (3,718–9,369)	6,885	348,985	3,573 (2,303–4,843)	3,687	563,242
MSA:											
MSA	10,498,173	28,760 (25,998–31,522)	5,752	28,935	2,156,249	6,651 (5,305–7,997)	6,922	1,838,675	5,559 (4,557–6,561)	5,781	1,965,145
NonMSA	1,738,391	13,979 (11,014–16,943)	2,796	13,835	*	*	*	395,911	3,184 (1,985–4,384)	2,843	*

Rate per 100,000 based on 1992, 1994, 1996, 1998 and 2000 population estimates from CPS, CPS Utilities, Unicon Research Corp. for relevant demographic categories of male civilian noninstitutionalized population 40 years or older in the United States, age adjusted grouped years adjusted to the United States Census derived age distribution of the mid point of years, individual years age adjusted to the United States Census derived age distribution of the year under analysis and individuals with missing or unavailable race and ethnicity, and missing MSA included in the total (counts may not sum to total due to rounding) (source: NAMCS, 1992, 1994, 1996, 1998 and 2000).

* Values do not meet reliability or precision standard.

TABLE 8. Physician office visits by male Medicare beneficiaries with prostate cancer as primary diagnosis

	1992			1995			1998			2001	
	Count	Rate (95% CI)	Age Adjusted Rate	Count	Rate (95% CI)	Age Adjusted Rate	Count	Rate (95% CI)	Age Adjusted Rate	Count	Rate (95% CI)
Total all ages	1,600,000	10,738 (10,668–10,808)		2,370,000	15,543 (15,462–15,625)		2,240,000	15,472 (15,388–15,555)		2,280,000	14,785 (14,705–14,864)
Total younger than 65	19,220	615 (577–654)		36,040	1,046 (998–1,094)		42,720	1,243 (1,191–1,296)		46,820	1,230 (1,180–1,280)
Total 65 or older	1,580,000	13,424 (13,337–13,511)	14,389	2,330,000	19,785 (19,684–19,887)	20,978	2,200,000	19,900 (19,795–20,005)	20,561	2,230,000	19,227 (19,126–19,328)
Age:											
65–69	295,800	7,267 (7,155–7,380)		398,440	10,344 (10,208–10,480)		363,940	10,778 (10,630–10,926)		368,740	10,421 (10,278–10,563)
70–74	422,160	12,984 (12,820–13,147)		614,140	18,417 (18,231–18,603)		573,240	18,792 (18,596–18,988)		545,520	17,721 (17,531–17,912)
75–79	419,420	18,529 (18,303–18,755)		606,600	26,741 (26,484–26,999)		594,320	26,025 (25,771–26,280)		598,920	24,414 (24,174–24,655)
80–84	284,660	21,728 (21,413–22,044)		444,260	31,975 (31,629–32,322)		414,980	30,115 (29,773–30,458)		433,660	28,977 (28,652–29,302)
85–89	124,620	20,902 (20,440–21,363)		205,980	32,339 (31,825–32,853)		193,160	29,687 (29,190–30,183)		220,620	30,494 (30,020–30,969)
90–94	29,480	14,555 (13,868–15,242)		52,520	24,846 (24,023–25,670)		50,180	23,327 (22,527–24,126)		57,380	24,785 (23,979–25,551)
95–97	3,280	8,119 (6,928–9,309)		6,280	16,658 (14,976–18,340)		5,500	13,896 (12,372–15,419)		6,060	15,773 (14,144–17,402)
98 or Older	880	2,318 (1,641–2,995)		1,420	3,205 (2,472–3,939)		2,000	4,181 (3,378–4,983)		2,200	4,055 (3,312–4,797)
Race/ethnicity:											
White	1,390,000	11,047 (10,969–11,124)	10,991	2,070,000	15,961 (15,872–16,050)	15,882	1,950,000	15,951 (15,859–16,042)	15,865	1,960,000	15,008 (14,922–15,095)
Black	127,840	10,019 (9,786–10,252)	10,039	219,620	15,860 (15,588–16,133)	16,593	206,760	15,491 (15,216–15,765)	16,107	217,480	14,819 (14,561–15,076)
Asian	Not available	Not available	Not available	8,980	12,322 (11,254–13,389)	11,690	14,940	10,894 (10,157–11,631)	10,704	15,020	7,330 (6,825–7,834)
Hispanic	Not available	Not available	Not available	16,380	8,250 (7,709–8,792)	8,814	39,920	11,893 (11,403–12,383)	12,167	41,960	11,167 (10,717–11,618)
North American native	Not available	Not available	Not available	640	3,181 (2,097–4,264)	2,883	1,200	4,292 (3,230–5,354)	4,220	1,360	4,084 (3,132–5,036)
Region:											
Midwest	362,260	9,766 (9,631–9,902)	9,826	531,420	13,786 (13,632–13,940)	13,942	505,180	13,661 (13,504–13,817)	13,708	495,440	13,044 (12,893–13,196)
Northeast	344,580	10,866 (10,713–11,019)	10,909	573,600	18,035 (17,846–18,224)	17,937	507,460	18,259 (18,056–18,462)	18,050	504,160	17,253 (17,060–17,447)
South	603,420	11,520 (11,398–11,642)	11,465	875,680	15,962 (15,825–16,099)	16,014	861,120	16,044 (15,905–16,183)	16,292	894,900	15,410 (15,279–15,541)
West	272,220	11,270 (11,091–11,448)	11,213	356,680	15,381 (15,173–15,589)	15,111	330,420	14,775 (14,567–14,983)	14,389	344,760	13,930 (13,737–14,123)

Unweighted counts multiplied by 20 to arrive at values, rate per 100,000 male Medicare beneficiaries in the same demographic stratum, age adjusted rate adjusted to the 2000 United States Census and individuals of other races, unknown race and ethnicity, and other region included in the total (counts less than 600 should be interpreted with caution) (source: Centers for Medicare and Medicaid Services, 5% Carrier and Outpatient Files, 1992, 1995, 1998 and 2001).

TABLE 9. Expenditures for prostate cancer by service site

	\$ Expenditure (% total)
1994:	
Hospital outpt	129,108,028 (12.9)
Physician office	97,839,385 (9.8)
Ambulatory surgery	76,645,818 (7.6)
Emergency room	9,590,867 (1.0)
Inpt	689,630,760 (68.8)
Total	1,002,814,857
1996:	
Hospital outpt	62,988,055 (6.5)
Physician office	115,394,094 (12.0)
Ambulatory surgery	77,341,725 (8.0)
Emergency room	10,444,787 (1.1)
Inpt	697,677,985 (72.4)
Total	963,846,646
1998:	
Hospital outpt	112,133,820 (11.8)
Physician office	143,409,456 (15.1)
Ambulatory surgery	141,018,192 (14.9)
Emergency room	13,811,416 (1.5)
Inpt	537,794,704 (56.7)
Total	948,167,588
2000:	
Hospital outpt	174,484,751 (13.5)
Physician office	305,584,466 (23.6)
Ambulatory surgery	179,080,421 (13.8)
Emergency room	15,553,104 (1.2)
Inpt	621,098,169 (47.9)
Total	1,295,800,912

Source: NAMCS, National Hospital and Ambulatory Medical Care Survey, HCUP and Medical Expenditure Panel Survey, 1994, 1996, 1998 and 2000.

For example, there may be additional indirect costs due to premature retirement and lost productivity that were not captured in the Urologic Diseases in America data sets.

Max et al estimated the indirect costs of prostate cancer in California by estimating patient lost (lifetime) earnings discounted at a 3% annual rate.¹⁰ They estimated that the indirect costs due to premature mortality totaled \$180 million, equal to the direct medical costs of treating the condition. Bradley et al queried a population based cohort of prostate cancer survivors and age matched controls, and found that men with prostate cancer were 10% less likely to be working 6 months after a prostate cancer diagnosis than those without the disease.¹¹ More importantly at 1 year 26% of prostate cancer survivors who returned to work reported

that the disease interfered with their ability to function on the job.

Finally, the reader is reminded that Medicare expenditures for medical androgen suppression therapy amounted to \$478 million in 1994, representing 34% of the total Medicare expenditure for prostate cancer.¹² These values are likely to have increased in the last decade since the use of drug therapy has increased rapidly.^{13,14} Medicare recently decreased the reimbursement rates for outpatient hormonal ablation therapy, which will likely decrease the overall economic burden of this treatment in the future. Nevertheless, these treatments still contribute greatly to the overall cost of prostate cancer in the United States and they may represent an area for which cost savings could be generated.

CONCLUSIONS

Prostate cancer is a significant public health problem in the United States. This tumor remains the most common solid tumor in American men and the second leading cause of cancer death. While the debate regarding prostate cancer screening continues, there is no argument that the incidence of the disease has increased in the PSA era. Not surprisingly there has been a stage migration and a decrease in short-term mortality rates. Whether this is due to a true beneficial effect of screening, or to lead or lag time bias still remains to be seen.

The introduction of PSA screening has had a major impact on health care use rates in prostate cancer. Use of inpatient care decreased in the 1990s, while radical prostatectomy rates decreased in older patients and increased in younger ones. Outpatient health care use increased as the overall number of men living with prostate cancer also increased, and many of the elements of prostate cancer care were shifted to the outpatient setting. There is significant regional and ethnic variation in patterns of health care use, reflecting clinical uncertainty regarding the optimal treatment for this condition. Only through well designed, randomized clinical trials will we be able to eliminate this variation and determine the optimal care for men newly diagnosed with prostate cancer.

TABLE 10. Medicare beneficiary expenditures for prostate cancer treatment

Service Type	\$ Expenditures (% total)			
	1992	1995	1998	2001
65 or Older:				
Hospital outpatient	199,884,080 (24.1)	185,917,800 (28.4)	215,481,000 (30.0)	250,870,360 (28.2)
Physician office	74,274,100 (9.0)	107,163,440 (16.4)	158,207,040 (22.0)	227,776,200 (25.6)
Ambulatory surgery	53,091,600 (6.4)	53,952,000 (8.2)	116,847,360 (16.2)	160,356,000 (18.0)
Emergency room	2,455,000 (0.3)	2,665,680 (0.4)	1,869,840 (0.3)	2,218,220 (0.2)
Inpatient	500,158,960 (60.3)	305,255,600 (46.6)	226,821,840 (31.5)	247,542,400 (27.9)
Totals	829,863,740	654,954,520	719,227,080	888,763,180
Younger than 65:				
Hospital outpatient	2,522,800 (15.6)	5,149,360 (27.7)	6,003,440 (26.6)	6,998,500 (23.3)
Physician office	922,560 (5.7)	1,910,120 (10.3)	3,118,560 (13.8)	4,447,900 (11.5)
Ambulatory surgery	805,200 (5.0)	0 (0.0)	3,526,400 (15.6)	8,342,880 (21.6)
Emergency room	— (0.0)	— (0.0)	— (0.0)	— (0.0)
Inpatient	11,936,800 (73.7)	11,558,820 (62.1)	9,952,820 (44.0)	16,872,060 (43.6)
Totals	16,187,360	18,618,300	22,601,220	38,661,340

Source: Centers for Medicare and Medicaid Services, 1992, 1995, 1998 and 2001.

TABLE 11. *Estimated annual expenditures for privately insured employees with and without prostate cancer medical claim in 2002*

	\$ Annual Expenditures/Pt Ages 50–64 Without Prostate Ca (203,181 men)			\$ Annual Expenditures/Pt Ages 50–64 With Prostate Ca (3,135 men)		
	Medical	Prescription Drugs	Totals	Medical	Prescription Drugs	Totals
All	3,182	1,244	4,426	9,551	1,894	11,445
Age:						
50–54	3,302	1,306	4,608	8,108	1,797	9,905
55–59	3,460	1,291	4,751	6,997	1,768	8,765
60–64	3,302	1,159	4,461	6,181	1,859	8,040
Region:						
Midwest	2,996	1,232	4,228	8,989	1,888	10,877
Northeast	3,110	1,332	4,442	9,331	2,033	11,364
South	3,322	1,175	4,497	9,965	1,782	11,747
West	3,439	1,238	4,677	10,317	1,908	12,225

Primary beneficiaries 40 to 64 years old with employer provided insurance who were continuously enrolled in 2002, estimated annual expenditures were derived from multivariate models controlled for age, gender, work status (active/retired), median household income based on zip code, urban/rural residence, medical and drug plan characteristics (managed care, deductible and co-insurance/co-payments) and binary indicators for 28 chronic disease conditions with predicted expenditures for males 40 to 49 years old are omitted due to small sample size (source: Ingenix, 2002).

Abbreviations and Acronyms

- CPS = Current Population Survey
- DPSS = Division of Prevention and Population Sciences
- HCUP = Health Care Cost and Utilization Project
- MSA = metropolitan statistical area
- NAMCS = National Ambulatory Medical Care Survey
- PSA = prostate specific antigen
- SEER = Surveillance, Epidemiology and End Results Program

REFERENCES

1. Merrill RM, Weed DL and Feuer EJ: The lifetime risk of developing prostate cancer in white and black men. *Cancer Epidemiol Biomarkers Prev* 1997; **6**: 763.
2. Merrill RM and Stephenson RA: Trends in mortality rates in patients with prostate cancer during the era of prostate specific antigen screening. *J Urol* 2000; **163**: 503.
3. Litwin MS, Saigal CS, Yano EM, Avila C, Geschwind SA, Hanley JM et al: Urologic Diseases in America Project: analytical methods and principal findings. *J Urol* 2005; **173**: 933.
4. Chan JM, Jou RM and Carroll PR: The relative impact and future burden of prostate cancer in the United States. *J Urol* 2004; **172**: S13.
5. Bartsch G, Horninger W, Klocker H, Reissigl A, Oberaigner W, Schonitzer D et al: Prostate cancer mortality after introduction of prostate-specific antigen mass screening in the Federal State of Tyrol, Austria. *Urology* 2001; **58**: 417.
6. Lu-Yao G, Albertsen PC, Stanford JL, Stukel TA, Walker-Corkery ES and Barry MJ: Natural experiment examining impact of aggressive screening and treatment on prostate cancer mortality in two fixed cohorts from Seattle area and Connecticut. *BMJ* 2002; **325**: 740.
7. Bubolz T, Wasson JH, Lu-Yao G and Barry MJ: Treatments for prostate cancer in older men: 1984–1997. *Urology* 2001; **58**: 977.
8. Ellison LM, Heaney JA and Birkmeyer JD: Trends in the use of radical prostatectomy for treatment of prostate cancer. *Eff Clin Pract* 1999; **2**: 228.
9. Bill-Axelsson A, Holmberg L, Ruutu M, Haggman M, Andersson SO, Bratell S et al: Radical prostatectomy versus watchful waiting in early prostate cancer. *N Engl J Med* 2005; **352**: 1977.
10. Max W, Rice DP, Sung HY, Michel M, Breuer W and Zhang X: The economic burden of prostate cancer, California, 1998. *Cancer* 2002; **94**: 2906.
11. Bradley CJ, Neumark D, Luo Z, Bednarek H and Schenk M: Employment outcomes of men treated for prostate cancer. *J Natl Cancer Inst* 2005; **97**: 958.
12. Cancer Facts and Figures, 2005. Atlanta: American Cancer Society 2005.
13. Cooperberg MR, Grossfeld GD, Lubeck DP and Carroll PR: National practice patterns and time trends in androgen ablation for localized prostate cancer. *J Natl Cancer Inst* 2003; **95**: 981.
14. Zeliadt SB, Potosky AL, Etzioni R, Ramsey DS and Penson DF: Racial disparity in primary and adjuvant treatment for nonmetastatic prostate cancer: SEER-Medicare trends 1991 to 1999. *Urology* 2004; **64**: 1171.