

Secondary Cancer and Relapse Rates Following Radical Prostatectomy for Prostate-Confined Cancer

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In the SEER database, it is relatively easy to identify secondary cancers that follow an initial diagnosis of cancer. However, the SEER public-use data does not explicitly capture relapse of the initial cancer. One can assume that organ-confined prostate cancer treated by radical prostatectomy will show no evidence of disease after treatment. Death due to prostate cancer in such cases can be assumed to follow a relapse of previously occult metastatic disease. We devised an estimate of the timing of these relapses and tabulated rates for both new primaries and relapses following radical prostatectomy for organ-confined prostate cancer.

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INTRODUCTION

Prostate cancer is a common cancer in men worldwide. In the United States, it has the highest incidence rate among all cancer sites, even when both sexes are considered (breast cancer is second). Prostate cancer is characterized by slow indolent growth as well as rapidly increasing incidence and prevalence with older age.

We previously reported on secondary cancers following an initial diagnosis of breast cancer using the Surveillance Epidemiology and End-Results (SEER) public use database.¹ In that study, the rates of both recurrent breast cancers (new breast primaries) and new secondary cancers in other organs were analyzed using exposure-based methodology. We wanted to study comparable rates in

prostate cancer, but the two cancers and their treatments are very different.

Radical prostatectomy is the only treatment for prostate cancer that can claim to eradicate the primary tumor. There is no recurrence of prostate cancer following radical prostatectomy. SEER captures specific pathologic staging for radical prostatectomy cases. It can be presumed that there is no evidence of disease post radical prostatectomy for cases where the pathologic stage indicates the cancer was limited to the prostate gland (T2 disease). SEER also captures cause of death codes with a high degree of specificity for cancer deaths. A significant number of men with early stage prostate cancer treated by radical prostatectomy go on to die of prostate cancer. One can presume that such cases represent a relapse

of the initial cancer, probably from an occult metastasis.

We decided to study relapse rates and secondary cancer rates following prostate cancer diagnosis.

METHODS

The SEER program is managed by the National Cancer Institute (NCI). SEER data has been collected since 1973 from 7 founding cancer registries.² Seattle was added in 1974 and Atlanta in 1975. More recent additions were made in 1992 and 2000.³ The data includes de-identified but otherwise seriatim data with details about newly diagnosed cancer cases and follow-up information including date and cause of death. This data is available to qualified researchers in the form of re-coded public use data files.

All data analysis began with a subset of SEER data consisting of men diagnosed with adenocarcinoma of the prostate during the years 1988–2003. From this, two other datasets were formed:

1. Men with prostate-confined disease treated by radical prostatectomy
2. Men who died of prostate cancer after initially presenting with metastatic prostate cancer

To define the first dataset, it was necessary to carefully categorize cases by pathologic stage, a need complicated by the fact that SEER had no such coding prior to 1988. Between 1988 and 2003, SEER used 4 different coding systems for pathologic stage. We decided to map all the different SEER pathologic stage codes to a single system by matching the verbal descriptions of the various codes. We chose current definitions of prostate cancer stages from a leading cancer textbook,⁴ and we made slight modifications to accommodate SEER practices. See Table 1 – note that there are no T1 stages in SEER's pathologic staging.

The “p” prefix in Table 1 indicates pathologic stage – we use a similar cT system for

Table 1. Pathologic Stage Definitions

pT2	Confined to prostate but neither 2a nor 2b nor 2c; this includes “into capsule” and “into apex”
pT2a	1/2 lobe or less or tumor size \leq 1.5 cm
pT2b	>1/2 lobe or tumor size > 1.5 cm; not 2 lobes
pT2c	2 lobes
pT3	Extension through prostatic capsule
pT3a	Unilateral extra-capsular extension
pT3b	Bilateral extra-capsular extension
pT3c	Seminal vesicle invasion
pT4	Tumor is fixed or invades adjacent structure other than SV
pT4a	Tumor invades bladder neck, external sphincter, or rectum
pT4b	Tumor invades levator muscles or fixed to pelvic walls
pM	Distant metastases

clinical stages in mortality studies. Note the use of tumor size in pT2a and pT2b. This was added to accommodate SEER data from the 1988–1993 and 1998–2003 eras. In the 1988–1993 era, the codes in the same extent of disease field were used for clinical and pathologic staging with pathologic staging taking precedence over clinical staging. New codes specific to pathologic stages were added in 1994. In 1995, a new extent of disease field specific to pathologic staging was added. The codes for this field were later updated for 1998–2003. Yet another coding scheme was introduced in 2004, but we chose to limit the scope of our study to cases diagnosed in the years 1988–2003. Follow-up ended on December 31, 2004.

See SEER documentation for detailed descriptions of the numeric codes.⁵

After recoding was completed, we selected all observations for which the pathologic stage was organ-confined (the T2's) and which were treated by radical prostatectomy. We then used previously reported methods to determine if and when a secondary cancer was diagnosed.¹ A failure flag was set and the date of diagnosis for the second cancer was used as the failure date.

Table 2. Distributions of Diagnoses by Pathologic Stage vs SEER Coding Era

Path stage	Year Band				Total
	1988–1993	1994	1995–1997	1998–2003	
T2	10,590	2024	6399	19,852	38,865
T2a	980	161	879	1750	3770
T2b	383	640	237	308	1568
T2c	3126	940	3354	9343	16,763
Total	15,079	3765	10,869	31,253	60,966

Table 3. New Primary Cancers by Age and Time Since Diagnosis of Index Cancer

Age Band	Interval										Total
	1	2	3	4	5	6	7	8	9	10	
50–54	31 6258.7 5.0 (3,7)	26 5868.4 4.4 (3,6)	19 5108.8 3.7 (2,6)	14 4301.6 3.3 (2,5)	11 3542.9 3.1 (2,6)	14 2881.8 4.9 (3,8)	13 2279.1 5.7 (3,10)	9 1802.0 5.0 (2,9)	7 1433.2 4.9 (2,10)	4 1108.6 3.6 (1,9)	148 34585.2 4.3 (4,5)
55–59	66 11255.2 5.9 (5,7)	49 10529.4 4.7 (3,6)	53 9187.6 5.8 (4,8)	57 7816.8 7.3 (6,9)	36 6611.7 5.4 (4,8)	40 5455.1 7.3 (5,10)	41 4439.2 9.2 (7,13)	27 3670.2 7.4 (5,11)	27 2990.0 9.0 (6,13)	28 2343.9 11.9 (8,17)	424 64299.1 6.6 (6,7)
60–64	141 14610.3 9.7 (8,11)	94 13805.3 6.8 (6,8)	100 12314.9 8.1 (7,10)	90 10869.8 8.3 (7,10)	99 9482.6 10.4 (8,13)	85 8148.5 10.4 (8,13)	65 6866.6 9.5 (7,12)	82 5826.1 14.1 (11,17)	59 4835.5 12.2 (9,16)	44 3923.2 11.2 (8,15)	859 90682.7 9.5 (9,10)
65–69	199 15327.4 13.0 (11,15)	139 14560.1 9.5 (8,11)	160 13208.1 12.1 (10,14)	168 11798.6 14.2 (12,17)	112 10450.2 10.7 (9,13)	120 9145.1 13.1 (11,16)	100 7809.7 12.8 (10,16)	102 6671.1 15.3 (12,19)	84 5612.7 15.0 (12,19)	69 4652.2 14.8 (12,19)	1253 99235.2 12.6 (12,13)
70–74	128 8399.2 15.2 (13,18)	102 7997.0 12.8 (10,15)	122 7311.0 16.7 (14,20)	92 6596.5 13.9 (11,17)	90 5881.7 15.3 (12,19)	90 5182.9 17.4 (14,21)	83 4493.6 18.5 (15,23)	67 3906.4 17.2 (13,22)	55 3320.8 16.6 (12,22)	52 2767.3 18.8 (14,25)	881 55856.4 15.8 (15,17)
75–79	27 1663.6 16.2 (11,24)	28 1575.7 17.8 (12,26)	25 1429.3 17.5 (11,26)	20 1280.0 15.6 (10,24)	23 1133.9 20.3 (13,30)	15 975.8 15.4 (9,25)	20 835.3 23.9 (15,37)	18 710.3 25.3 (15,40)	10 605.3 16.5 (8,30)	17 503.3 33.8 (20,54)	203 10712.5 18.9 (16,22)
80–84	4 137.3 29.1 (8,75)	2 130.9 15.3 (2,55)	4 118.6 33.7 (9,86)	4 99.1 40.4 (11,103)	1 85.3 11.7 (0,65)	2 73.8 27.1 (3,98)	0 65.2 0.0 (0,57)	3 54.7 54.9 (11,160)	2 41.2 48.5 (6,175)	0 30.5 0.0 (0,121)	22 836.6 26.3 (16,40)
85+	1 28.4 35.2 (1,196)	1 24.2 41.3 (1,230)	0 21.4 0.0 (0,173)	0 18.0 0.0 (0,204)	0 13.2 0.0 (0,279)	0 12.6 0.0 (0,292)	0 11.5 0.0 (0,322)	0 11.0 0.0 (0,335)	0 9.2 0.0 (0,402)	0 7.0 0.0 (0,527)	2 156.5 12.8 (2,46)
Total	597 57680.2 10.4 (10,11)	441 54490.9 8.1 (7,9)	483 48699.5 9.9 (9,11)	445 42780.4 10.4 (9,11)	372 37201.6 10.0 (9,11)	366 31875.7 11.5 (10,13)	322 26800.2 12.0 (11,13)	308 22651.7 13.6 (12,15)	244 18848.0 12.9 (11,15)	214 15335.9 14.0 (12,16)	3792 356364.2 10.6 (10,11)

Note: actual count, exposure (person-years), rate (per 1000 person-years), 95% C.I. for rate (rounded).

Table 4. New Primary Cancers by Stage and Time Since Diagnosis of Index Cancer

Stage	Interval										Total
	1	2	3	4	5	6	7	8	9	10	
pT2	374	284	310	281	238	229	210	199	169	137	2431
	36814.1	34757.4	31099.7	27387.6	23817.8	20399.3	17110.6	14530.8	12302.9	10145.3	228365.6
	10.2	8.2	10.0	10.3	10.0	11.2	12.3	13.7	13.7	13.5	10.6
	(9,11)	(7,9)	(9,11)	(9,12)	(9,11)	(10,13)	(11,14)	(12,16)	(12,16)	(11,16)	(10,11)
pT2a	33	22	23	29	26	21	25	18	18	12	227
	3551.5	3374.8	3057.5	2739.3	2425.6	2126.4	1822.9	1539.4	1215.4	950.4	22803.2
	9.3	6.5	7.5	10.6	10.7	9.9	13.7	11.7	14.8	12.6	10.0
	(6,13)	(4,10)	(5,11)	(7,15)	(7,16)	(6,15)	(9,20)	(7,18)	(9,23)	(7,22)	(9,11)
pT2b	19	5	17	18	12	13	13	15	9	9	130
	1499.1	1464.4	1398.2	1318.5	1243.4	1157.3	1072.3	979.1	868.3	778.0	11778.4
	12.7	3.4	12.2	13.7	9.7	11.2	12.1	15.3	10.4	11.6	11.0
	(8,20)	(1,8)	(7,19)	(8,22)	(5,17)	(6,19)	(6,21)	(9,25)	(5,20)	(5,22)	(9,13)
pT2c	171	130	133	117	96	103	74	76	48	56	1004
	15815.4	14894.3	13144.2	11335.0	9714.8	8192.8	6794.4	5602.3	4461.5	3462.3	93417.0
	10.8	8.7	10.1	10.3	9.9	12.6	10.9	13.6	10.8	16.2	10.7
	(9,13)	(7,10)	(8,12)	(9,12)	(8,12)	(10,15)	(9,14)	(11,17)	(8,14)	(12,21)	(10,11)
Total	597	441	483	445	372	366	322	308	244	214	3792
	57680.2	54490.9	48699.5	42780.4	37201.6	31875.7	26800.2	22651.7	18848.0	15335.9	356364.2
	10.4	8.1	9.9	10.4	10.0	11.5	12.0	13.6	12.9	14.0	10.6
	(10,11)	(7,9)	(9,11)	(9,11)	(9,11)	(10,13)	(11,13)	(12,15)	(11,15)	(12,16)	(10,11)

Note: actual count, exposure (person-years), rate (per 1000 person-years), 95% C.I. for rate (rounded).

Table 5. New Primary Cancers by Gleason Score and Time Since Diagnosis of Index Cancer

Gleason Score	Interval										Total
	1	2	3	4	5	6	7	8	9	10	
Gs2–4	49	27	44	40	43	41	42	38	31	23	378
	3878.6	3802.1	3693.0	3537.6	3355.2	3180.8	2957.6	2685.1	2379.7	2081.4	31551.1
	12.6	7.1	11.9	11.3	12.8	12.9	14.2	14.2	13.0	11.1	12.0
	(9,17)	(5,10)	(9,16)	(8,15)	(9,17)	(9,17)	(10,19)	(10,19)	(9,18)	(7,17)	(11,13)
Gs5–7	443	335	371	329	272	277	236	221	177	156	2817
	44744.3	42550.3	38109.2	33224.6	28708.4	24344.0	20223.7	16932.0	13968.0	11246.3	274050.7
	9.9	7.9	9.7	9.9	9.5	11.4	11.7	13.1	12.7	13.9	10.3
	(9,11)	(7,9)	(9,11)	(9,11)	(8,11)	(10,13)	(10,13)	(11,15)	(11,15)	(12,16)	(10,11)
Gs8–10	105	79	68	76	57	48	44	49	36	35	597
	9057.2	8138.5	6897.4	6018.2	5138.0	4351.0	3618.9	3034.5	2500.2	2008.3	50762.3
	11.6	9.7	9.9	12.6	11.1	11.0	12.2	16.1	14.4	17.4	11.8
	(9,14)	(8,12)	(8,12)	(10,16)	(8,14)	(8,15)	(9,16)	(12,21)	(10,20)	(12,24)	(11,13)
Total	597	441	483	445	372	366	322	308	244	214	3792
	57680.2	54490.9	48699.5	42780.4	37201.6	31875.7	26800.2	22651.7	18848.0	15335.9	356364.2
	10.4	8.1	9.9	10.4	10.0	11.5	12.0	13.6	12.9	14.0	10.6
	(10,11)	(7,9)	(9,11)	(9,11)	(9,11)	(10,13)	(11,13)	(12,15)	(11,15)	(12,16)	(10,11)

Note: actual count, exposure (person-years), rate (per 1000 person-years), 95% C.I. for rate (rounded).

Table 6. Relapsed Prostate Cancer by Age and Time Since Diagnosis of Index Cancer

Age Band	Interval										Total
	1	2	3	4	5	6	7	8	9	10	
50-54	5	7	6	7	6	7	8	4	2	1	53
	6258.7	5868.4	5108.8	4301.6	3542.9	2881.8	2279.1	1802.0	1433.2	1108.6	34585.2
	0.8	1.2	1.2	1.6	1.7	2.4	3.5	2.2	1.4	0.9	1.5
	(0,2)	(0,2)	(0,3)	(1,3)	(1,4)	(1,5)	(2,7)	(1,6)	(0,5)	(0,5)	(1,2)
55-59	9	13	13	5	9	8	3	3	3	4	70
	11255.2	10529.4	9187.6	7816.8	6611.7	5455.1	4439.2	3670.2	2990.0	2343.9	64299.1
	0.8	1.2	1.4	0.6	1.4	1.5	0.7	0.8	1.0	1.7	1.1
	(0,2)	(1,2)	(1,2)	(0,1)	(1,3)	(1,3)	(0,2)	(0,2)	(0,3)	(0,4)	(1,1)
60-64	15	17	19	10	14	14	10	9	15	7	130
	14610.3	13805.3	12314.9	10869.8	9482.6	8148.5	6866.6	5826.1	4835.5	3923.2	90682.7
	1.0	1.2	1.5	0.9	1.5	1.7	1.5	1.5	3.1	1.8	1.4
	(1,2)	(1,2)	(1,2)	(0,2)	(1,2)	(1,3)	(1,3)	(1,3)	(2,5)	(1,4)	(1,2)
65-69	29	23	29	23	25	25	21	20	15	9	219
	15327.4	14560.1	13208.1	11798.6	10450.2	9145.1	7809.7	6671.1	5612.7	4652.2	99235.2
	1.9	1.6	2.2	1.9	2.4	2.7	2.7	3.0	2.7	1.9	2.2
	(1,3)	(1,2)	(1,3)	(1,3)	(2,4)	(2,4)	(2,4)	(2,5)	(1,4)	(1,4)	(2,3)
70-74	19	13	24	13	22	19	16	14	13	10	163
	8399.2	7997.0	7311.0	6596.5	5881.7	5182.9	4493.6	3906.4	3320.8	2767.3	55856.4
	2.3	1.6	3.3	2.0	3.7	3.7	3.6	3.6	3.9	3.6	2.9
	(1,4)	(1,3)	(2,5)	(1,3)	(2,6)	(2,6)	(2,6)	(2,6)	(2,7)	(2,7)	(2,3)
75-79	2	4	6	7	2	5	2	2	4	1	35
	1663.6	1575.7	1429.3	1280.0	1133.9	975.8	835.3	710.3	605.3	503.3	10712.5
	1.2	2.5	4.2	5.5	1.8	5.1	2.4	2.8	6.6	2.0	3.3
	(0,4)	(1,6)	(2,9)	(2,11)	(0,6)	(2,12)	(0,9)	(0,10)	(2,17)	(0,11)	(2,5)
80-84	1	1	1	3	0	0	0	0	0	0	6
	137.3	130.9	118.6	99.1	85.3	73.8	65.2	54.7	41.2	30.5	836.6
	7.3	7.6	8.4	30.3	0.0	0.0	0.0	0.0	0.0	0.0	7.2
	(0,41)	(0,43)	(0,47)	(6,88)	(0,43)	(0,50)	(0,57)	(0,67)	(0,90)	(0,121)	(3,16)
85+	0	0	0	0	0	0	0	0	0	0	0
	28.4	24.2	21.4	18.0	13.2	12.6	11.5	11.0	9.2	7.0	156.5
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	(0,130)	(0,152)	(0,173)	(0,204)	(0,279)	(0,292)	(0,322)	(0,335)	(0,402)	(0,527)	(0,24)
Total	80	78	98	68	78	78	60	52	52	32	676
	57680.2	54490.9	48699.5	42780.4	37201.6	31875.7	26800.2	22651.7	18848.0	15335.9	356364.2
	1.4	1.4	2.0	1.6	2.1	2.4	2.2	2.3	2.8	2.1	1.9
	(1,2)	(1,2)	(2,2)	(1,2)	(2,3)	(2,3)	(2,3)	(2,3)	(2,4)	(1,3)	(2,2)

Note: actual count, exposure (person-years), rate (per 1000 person-years), 95% C.I. for rate (rounded).

This second dataset (men who died of prostate cancer after initially presenting with metastatic prostate cancer) was easily defined. The goal in using this dataset was not a survival analysis for individuals presenting with metastatic prostate cancer. Instead, we needed an estimate of how long before death someone would present with metastatic

disease, given that they died of prostate cancer. From this second dataset, we identified the 50th percentile to be 903 days (2.47 years).

Returning to the first dataset, we flagged all deaths where the cause of death was determined to be prostate cancer. We assumed that failure (relapse) in these cases

Table 7. Relapsed Prostate Cancer by Stage and Time Since Diagnosis of Index Cancer

Stage	Interval										Total
	1	2	3	4	5	6	7	8	9	10	
pT2	48	58	67	47	52	43	46	41	38	18	458
	36814.1	34757.4	31099.7	27387.6	23817.8	20399.3	17110.6	14530.8	12302.9	10145.3	228365.6
	1.3	1.7	2.2	1.7	2.2	2.1	2.7	2.8	3.1	1.8	2.0
pT2a	(1,2)	(1,2)	(2,3)	(1,2)	(2,3)	(2,3)	(2,4)	(2,4)	(2,4)	(1,3)	(2,2)
	8	0	7	3	2	5	4	0	4	4	37
	3551.5	3374.8	3057.5	2739.3	2425.6	2126.4	1822.9	1539.4	1215.4	950.4	22803.2
pT2b	2.3	0.0	2.3	1.1	0.8	2.4	2.2	0.0	3.3	4.2	1.6
	(1,4)	(0,1)	(1,5)	(0,3)	(0,3)	(1,5)	(1,6)	(0,2)	(1,8)	(1,11)	(1,2)
	3	3	5	3	10	5	1	2	2	0	34
pT2c	1499.1	1464.4	1398.2	1318.5	1243.4	1157.3	1072.3	979.1	868.3	778.0	11778.4
	2.0	2.0	3.6	2.3	8.0	4.3	0.9	2.0	2.3	0.0	2.9
	(0,6)	(0,6)	(1,8)	(0,7)	(4,15)	(1,10)	(0,5)	(0,7)	(0,8)	(0,5)	(2,4)
Total	21	17	19	15	14	25	9	9	8	10	147
	15815.4	14894.3	13144.2	11335.0	9714.8	8192.8	6794.4	5602.3	4461.5	3462.3	93417.0
	1.3	1.1	1.4	1.3	1.4	3.1	1.3	1.6	1.8	2.9	1.6
Total	(1,2)	(1,2)	(1,2)	(1,2)	(1,2)	(2,5)	(1,3)	(1,3)	(1,4)	(1,5)	(1,2)
	80	78	98	68	78	78	60	52	52	32	676
	57680.2	54490.9	48699.5	42780.4	37201.6	31875.7	26800.2	22651.7	18848.0	15335.9	356364.2
Total	1.4	1.4	2.0	1.6	2.1	2.4	2.2	2.3	2.8	2.1	1.9
	(1,2)	(1,2)	(2,2)	(1,2)	(2,3)	(2,3)	(2,3)	(2,3)	(2,4)	(1,3)	(2,2)

Note: actual count, exposure (person-years), rate (per 1000 person-years), 95% C.I. for rate (rounded).

Table 8. Relapsed Prostate Cancer by Gleason Score and Time Since Diagnosis of Index Cancer

Gleason Score	Interval										Total
	1	2	3	4	5	6	7	8	9	10	
Gs2-4	7	2	5	1	5	2	4	6	3	4	39
	3878.6	3802.1	3693.0	3537.6	3355.2	3180.8	2957.6	2685.1	2379.7	2081.4	31551.1
	1.8	0.5	1.4	0.3	1.5	0.6	1.4	2.2	1.3	1.9	1.2
Gs5-7	(1,4)	(0,2)	(0,3)	(0,2)	(0,3)	(0,2)	(0,3)	(1,5)	(0,4)	(1,5)	(1,2)
	52	36	43	36	46	44	37	29	35	20	378
	44744.3	42550.3	38109.2	33224.6	28708.4	24344.0	20223.7	16932.0	13968.0	11246.3	274050.7
Gs8-10	1.2	0.8	1.1	1.1	1.6	1.8	1.8	1.7	2.5	1.8	1.4
	(1,2)	(1,1)	(1,2)	(1,2)	(1,2)	(1,2)	(1,3)	(1,2)	(2,3)	(1,3)	(1,2)
	21	40	50	31	27	32	19	17	14	8	259
Total	9057.2	8138.5	6897.4	6018.2	5138.0	4351.0	3618.9	3034.5	2500.2	2008.3	50762.3
	2.3	4.9	7.2	5.2	5.3	7.4	5.3	5.6	5.6	4.0	5.1
	(1,4)	(4,7)	(5,10)	(3,7)	(3,8)	(5,10)	(3,8)	(3,9)	(3,9)	(2,8)	(4,6)
Total	80	78	98	68	78	78	60	52	52	32	676
	57680.2	54490.9	48699.5	42780.4	37201.6	31875.7	26800.2	22651.7	18848.0	15335.9	356364.2
	1.4	1.4	2.0	1.6	2.1	2.4	2.2	2.3	2.8	2.1	1.9
Total	(1,2)	(1,2)	(2,2)	(1,2)	(2,3)	(2,3)	(2,3)	(2,3)	(2,4)	(1,3)	(2,2)

Note: actual count, exposure (person-years), rate (per 1000 person-years), 95% C.I. for rate (rounded).

occurred 903 days prior to death if the lifespan from initial prostate cancer diagnosis to death exceeded 1806 days. Where the lifespan was less than 1806 days, we estimated that failure occurred at the midpoint of that span.

There were no instances of recurrent prostate disease (new primaries arising in prostate). For secondary cancers, Tables 3–5 display incidence rates. Tables 6–9 display estimated rates of prostate cancer relapse.

Table 3 shows a general trend for the rate of new primary cancers to increase with the passage of time. The exception to this trend is the first interval wherein rates are generally higher than the next several intervals. This passage of time trend is again evident in Tables 4 and 5. There is no significant difference in rates of new primaries for the subsets of pathologic stage 2, nor for the 3 Gleason score bands.

In Table 6, age band 55–59 perhaps stands out as having a slightly lower rate of prostate cancer relapse. There is no significant difference between the stages (Table 7). Table 8 shows that Gleason scores of 8–10 are associated with a significantly greater risk of relapse.

Figure 1 shows both the rates of new primaries and relapses. The effect of the passage of time is evident in the rates of new primaries. Figure 2 graphically displays the data in Table 9 – relapse rates by age and Gleason score. The age band 85+ is included in Table 9 because it contributed exposure, but it is not shown in Figure 2 because there were no relapses in this band.

DISCUSSION

We have developed a unique way to estimate cancer relapse from the SEER database and have demonstrated its application to prostate cancer. We assumed that relapse would manifest as metastatic disease that was formerly occult at the time of the initial presentation of prostate cancer, and we assumed that these situations would

Table 9. Relapsed Prostate Cancer by Age and Gleason Score

Age Band	Gleason Score			Total
	Gs2–4	Gs5–7	Gs8–10	
50–54	1	29	23	53
	2483.2	28245.9	3856.2	34585.2
	0.4	1.0	6.0	1.5
	(0,2)	(1,1)	(4,9)	(1,2)
55–59	1	42	27	70
	4658.7	52175.0	7465.4	64299.1
	0.2	0.8	3.6	1.1
	(0,1)	(1,1)	(2,5)	(1,1)
60–64	12	73	45	130
	8426.7	70116.4	12139.6	90682.7
	1.4	1.0	3.7	1.4
	(1,2)	(1,1)	(3,5)	(1,2)
65–69	14	126	79	219
	9287.9	74542.6	15404.7	99235.2
	1.5	1.7	5.1	2.2
	(1,3)	(1,2)	(4,6)	(2,3)
70–74	10	87	66	163
	5373.4	40888.4	9594.6	55856.4
	1.9	2.1	6.9	2.9
	(1,3)	(2,3)	(5,9)	(2,3)
75–79	1	18	16	35
	1154.3	7433.8	2124.4	10712.5
	0.9	2.4	7.5	3.3
	(0,5)	(1,4)	(4,12)	(2,5)
80–84	0	3	3	6
	137.6	550.7	148.3	836.6
	0.0	5.4	20.2	7.2
	(0,27)	(1,16)	(4,59)	(3,16)
85+	0	0	0	0
	29.5	97.9	29.1	156.5
	0.0	0.0	0.0	0.0
	(0,125)	(0,38)	(0,127)	(0,24)
Total	39	378	259	676
	31551.1	274050.7	50762.3	356364.2
	1.2	1.4	5.1	1.9
	(1,2)	(1,2)	(4,6)	(2,2)

Note: actual count, exposure (person-years), rate (per 1000 person-years), 95% C.I. for rate (rounded).

manifest in the data as deaths due to prostate cancer. Our estimate of the timing of relapse preceding death from prostate cancer was informed by the data on prostate cancer deaths known to follow metastatic presentation.

It is not surprising that the grade and pathologic stage of the index prostate cancer

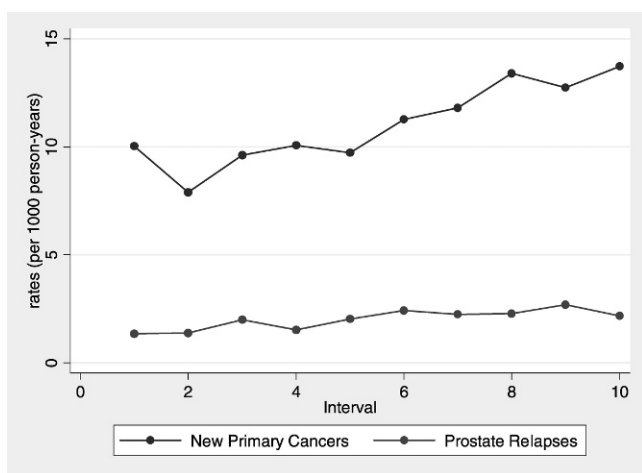


Figure 1. Comparison of rates for new primary cancers and relapse of prostate cancer.

have little association with the risk of new cancers arising in organs other than the prostate. Higher age and the passage of time are associated with the risk, but the associ-

ation is consistent with increased attained age.

In the study of prostate cancer mortality, grade, as measured by Gleason score, is thought to have greater association with mortality than other parameters including stage. Our prostate cancer relapse rates also show a significant association with higher Gleason scores and little, if any, association with stage. Of course, our study design is limited to observations with pathologic stages T2, T2a, T2b, and T2c.

The timing of prostate cancer relapse is only an estimate and we recognize that a number of deaths are missed since they have yet to result in death by the end of follow-up, but our estimation methods appear to yield plausible results in the analysis of well-defined prostate cancer cases. It remains to be seen whether these methods can be applied to other cancer categories.

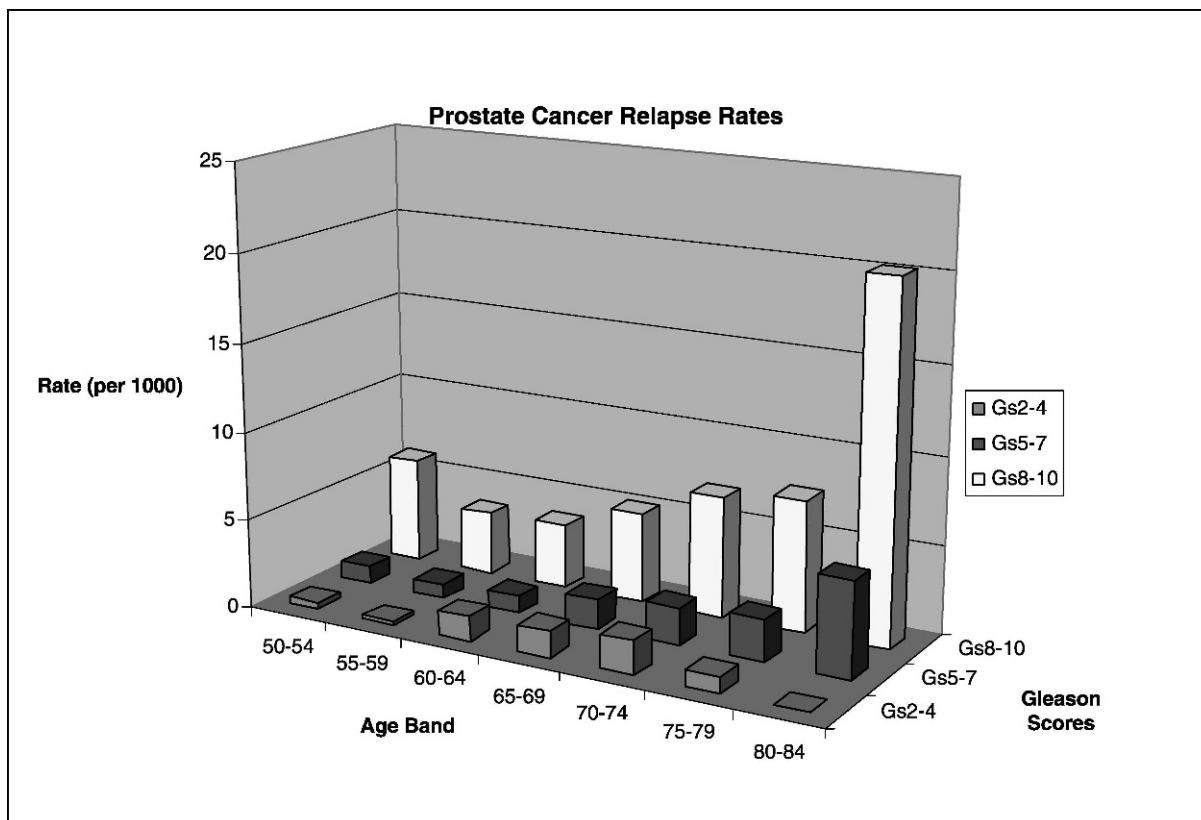


Figure 2. Prostate cancer relapse rates by age and Gleason score.

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