Title

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Comparative risk-adjusted mortality outcomes following primary surgery, radiation therapy, or androgen deprivation therapy for localized prostate cancer

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Abstract

Purpose—No adequate randomized trials comparing active treatment modalities for localized prostate cancer have been reported. We analyzed risk-adjusted cancer-specific mortality outcomes among men undergoing radical prostatectomy, external-beam radiation therapy, or primary androgen deprivation therapy.

Methods—The CaPSURE registry comprises men from 40 urologic practice sites followed prospectively under uniform protocols, regardless of treatment. 7538 men with localized disease were analyzed. Prostate cancer risk was assessed using the Kattan preoperative nomogram and the Cancer of the Prostate Risk Assessment (CAPRA) score, both well-validated instruments calculated from clinical data at the time of diagnosis. A parametric survival model was constructed to compare outcomes across treatments, adjusting for risk and age.

Results—226 men died of prostate cancer during followup. Adjusting for age and risk, the hazard ratio for cancer-specific mortality relative to prostatectomy was 2.21 (1.50–3.24) for radiation, and 3.22 (2.16–4.81) for androgen deprivation. Absolute differences between prostatectomy and radiation therapy were small for men at low risk, but increased substantially for men at intermediate and high risk. These results were robust to a variety of different analytic techniques including competing risks regression analysis, adjustment by CAPRA rather than Kattan score, and examination of overall survival as the endpoint.

Conclusions—Prostatectomy for localized prostate cancer was associated with a significant and substantial reduction in mortality relative to radiation or androgen deprivation monotherapy. Although not a randomized study, given the multiple adjustments and sensitivity analyses it is unlikely that unmeasured confounding would account for the large observed differences in survival.

Keywords

prostate neoplasms; comparative effectiveness; surgery; radiation; hormonal therapy; CaPSURE

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Introduction

For the more than 192,000 men expected to be diagnosed with prostate cancer annually,1 decision-making with respect to type and timing of treatment is complex: prostate cancer is surpassed only by lung cancer in its mortality burden among men in the United States1 yet the natural history of the disease is frequently indolent even among those untreated,2 and all available active treatments can be associated with significant adverse effects.3 No contemporary studies randomizing patients across primary treatments have been reported. Indeed, a systematic review recently commissioned by the Agency for Healthcare Research and Quality concluded that insufficient high-quality evidence exists to support one modality over another.4

The American Urological Association's clinical practice guideline for localized prostate cancer states that alternatives offered to patients should include active surveillance, radical prostatectomy, external-beam radiation therapy, and brachytherapy, but draws no conclusions regarding the relative efficacy of these alternatives.5 Primary androgen deprivation monotherapy for localized disease is not endorsed by the guideline, given inadequate evidence regarding outcomes; nonetheless, it is commonly used in practice.6, 7

Given prostate cancer's often prolonged course even among most cases which are ultimately lethal,8 studies with short- to intermediate-term followup may report outcomes only in terms of recurrence-free survival based on prostate specific antigen (PSA)-based definitions. Because many disparate definitions of biochemical recurrence have been proposed,9 comparing outcomes across modalities using PSA endpoints is problematic. Clinical endpoints—in particular prostate cancer-specific mortality (CSM) and all-cause mortality (ACM)—do not vary across treatments and are ultimately more relevant to patients. However, analyses at these endpoints require long-term followup.

In order to ascertain risk-adjusted comparative effectiveness of primary treatment approaches for prostate cancer, we conducted an analysis comparing CSM and ACM outcomes following prostatectomy, external-beam radiation, or primary androgen deprivation in a well-defined, multi-centre, prospective cohort of prostate cancer patients.

Patients and methods

Patient cohort

Data were abstracted from the Cancer of the Prostate Strategic Urologic Research Endeavour (CaPSURE™), a national disease registry accruing men with biopsy-proven prostate adeno-carcinoma managed at one of 40 urology practices, primarily community-based, across the United States. Participating urologists recruit men consecutively at diagnosis, and report initial and followup clinical data including staging tests and treatments. Comorbidities are recorded at baseline and in followup, comorbidity scoring is based on the Charlson index.10 The registry was initiated in 1995. Between 1995 and 1998 accrual was both prospective and retrospective; since 1998 all accrual has been prospective. Patients provide written, informed consent under local and central institutional review board supervision.

Patients are treated per their clinicians' usual practices, and are followed until death or withdrawal from the study. Clinicians report mortality events, and copies of state death certificates are obtained. CSM is determined if prostate cancer is listed as a primary, secondary, or tertiary cause of death on the certificate and no other malignancy is listed as a higher order cause. Perioperative mortality and death due complications of radiation and/or androgen deprivation counted toward all-cause but not cancer-specific mortality. If the

patient has been lost to followup or the certificate is not available, the National Death Index is queried to identify date and cause of death. Previous details regarding CaPSURE's methodology have been reported previously.11, 12

As of July 2008, 13,805 men had enrolled in CaPSURE. Of these, 8982 had localized disease (clinical stage ≤T3aN0), were treated with prostatectomy, external-beam radiation, or primary androgen deprivation, and had at least six months of followup recorded. 1444 with missing data needed to calculate both risk instruments described below were excluded. Thus 7538 men comprised the analytic dataset. Years of treatment ranged from 1987 to 2007; 26% of the patients were treated before 1997, 10% before 1995, and 1% before 1991.

Statistical analysis

Demographic and clinical characteristics of patients in each treatment group were compared using analysis of variance or chi-squared, as appropriate for continuous and categorical variables. To ensure that the analysis was not dependent on a specific risk adjustment approach, prostate cancer risk was assessed using two well-validated pre-treatment instruments. The first was the original nomogram published by Kattan et al., which yields a 0 to 100 score estimating likelihood of recurrence-free survival following radical prostatectomy from the PSA, biopsy Gleason grade, and clinical T stage.13–16 For this analysis, risk was expressed as 100-Kattan score, such that higher numbers indicate greater disease risk.

The second instrument was the UCSF Cancer of the Prostate Risk Assessment (CAPRA) score, a 0 to 10 score calculated from the PSA, biopsy Gleason grade, clinical T stage, age at diagnosis, and percent of biopsy cores positive.16–19 The CAPRA score predicts pathologic stage and biochemical recurrence-free survival, with each two-point increase in score indicating roughly a doubling of recurrence risk. Most recently, the score has been also shown to predict metastasis, CSM, and ACM across multiple primary treatments.20

Kaplan-Meier time to event curves were generated21 and outcomes compared via the log-rank test. Weibull parametric survival models were then constructed to compare outcomes, adjusting for case mix using either Kattan or CAPRA score and age. The primary endpoint was CSM; ACM was assessed as a secondary endpoint. In each case the hazard ratio (HR) with 95% confidence intervals (CI) was calculated for radiation and androgen deprivation compared to prostatectomy. The model was used to predict CSM at 10 years at various levels of risk. For the CSM analyses, patients dying of other causes were censored at the time of death. As a sensitivity analysis, the CSM analyses were also conducting using competing risks regression.22 Tests for interaction between risk and treatment were also performed.

Adjustment for neoadjuvant androgen deprivation did not alter the statistical significance of any variable in the model, and had minimal impact on the parameter estimates; therefore this variable were not included in the final model. The model was also tested excluding the 136 men who received adjuvant radiation therapy after prostatectomy, both with and without inclusion of adjuvant radiation as an additional predictor variable in the model. To limit the analysis to those receiving radiation treatment under relatively contemporary standards we performed a subset analysis limited to those treated since 1998. Finally, although the models have been shown to be accurate in predicting CSM across multiple treatments,20 it is possible that neither the Kattan nor CAPRA scores adequately reflect differences in risk across patients. Therefore, as an additional test we reassessed the model with Kattan scores for radical prostatectomy patients artificially increased, progressively by 5-point increments, to estimate the degree of unmeasured confounding beyond measured risk which would need

to be assumed in order to nullify the results. All statistical tests were two-sided, and analyses were performed using Stata version 11 (Stata Corp., College Station, TX).

Results

In total, 1293 (17.2%) men died, 226 (3.0%) of prostate cancer. Sociodemographic and clinical factors among patients in each primary treatment group are summarized in table 1. All comparisons among treatment groups for clinical and sociodemographic factors were statistically significant ($p<0.001$). Prostatectomy patients were younger, more frequently Caucasian, and had less comorbidity and lower risk disease features than those in other groups. There were 3 peri-operative deaths. Overall, 49.7% of the radiation patients received neoadjuvant and/or adjuvant hormonal therapy: 33.7%, 50.6%, and 67.6%, respectively, of those with CAPRA scores 0–2, 3–5, and 6–10. 6.7% of the prostatectomy patients received neoadjuvant therapy: 4.5%, 7.7%, and 19.3% respectively of those in each CAPRA score group. Mean ± SD duration of therapy was 7.9 ± 3.1 months.

Mean ± SD and median times to death were 6.8 ± 4.0 and 6.4 years, respectively, and mean and median followup times among those surviving were 4.2 ± 3.3 and 3.9 years. Median followup times were similar across treatments: 3.9, 4.5, and 3.6 years, respectively, for prostatectomy, radiation, and androgen deprivation patients; and across risk groups: 3.6, 4.1, and 4.0 years, respectively, for CAPRA 0–2, CAPRA 3–5, and CAPRA 6–10 patients. Unadjusted time-to-event curves for CSM are presented in figure 1. The differences in outcomes across treatments were statistically significant by log-rank test ($p<0.001$). Relative to prostatectomy, the unadjusted HRs for CSM were 2.46 (1.8–3.43) for radiation and 4.36 (3.21–5.93) for androgen deprivation.

The results of the primary risk-adjusted analysis are presented in table 2a. Adjusting for age and case mix using the Kattan score, the HRs for CSM relative to prostatectomy for radiation and androgen deprivation were 2.21 (1.50–3.24) and 3.22 (2.16–4.81), respectively. The HR for CSM for androgen deprivation relative to radiation was 1.45 (1.02–2.07). Adjusting for CAPRA rather than Kattan score yielded somewhat lower but similar HRs relative to prostatectomy: 1.63 (1.09–2.45) for radiation and 2.65 (1.75–4.01) for androgen deprivation, and 1.62 (1.11–2.36) for androgen deprivation relative to radiation. Use of competing risks regression likewise yielded similar results: relative to prostatectomy, the HRs were 2.00 (1.33–3.01) and 2.56 (1.62–4.03) for radiation and androgen deprivation, respectively; relative to radiation, the HR was 1.27 (0.88–1.84) for androgen deprivation.

Excluding 136 men receiving adjuvant radiation therapy after prostatectomy had no effect on the results of the model, whether or not radiation was included as a predictor in the model. In interaction analyses, there was no evidence that the difference between prostatectomy and radiation depended on baseline risk ($p=0.20$). There was suggestion that improved outcome with radiation compared to androgen deprivation increased for patients with higher risk disease ($p=0.07$), but as this did not meet statistical significance, survival differences were modeled assuming constant relative risk among treatments across different levels of risk.

Table 2b presents the results for ACM: adjusting for age, Kattan score, and comorbidity, the HR relative to prostatectomy for radiation was 1.58 (1.32–1.89) and for androgen deprivation was 2.25 (1.86–2.72). Relative to radiation, the HR for ACM for androgen deprivation was 1.43 (1.21–1.69). Virtually identical results were produced with adjustment for CAPRA rather than Kattan score. Figure 2 and table 3 present predicted 10-year CSM by 100-Kattan and CAPRA score, respectively, for each treatment. Predicted CSM increases

consistently with rising CAPRA score, from 1.5% to 32.8% for prostatectomy, 2.5 to 48.7% for radiation, and 4.0 to 66.3% for androgen deprivation.

In restricting the analysis to those treated since 1998, the number of CSM events fell to 67 among 5143 at risk. The HRs for CSM relative to prostatectomy in this subset were 2.7 (1.2–6.2) for radiation therapy and 6.5 (3.1–13.5) for androgen deprivation. In our sensitivity analysis for unmeasured confounding, in calculating the model with Kattan scores artificially increased for prostatectomy patients, the difference between prostatectomy and radiation patients remained statistically significant until the Kattan scores were increased by 20 points for prostatectomy patients, and did not change direction until the scores were increased by over 30 points (table 4).

Discussion

Uncertainty regarding optimal management of localized prostate cancer has produced wide and excessive local and regional variation in the utilization of various interventions.[23–25] In general, with increasing risk men are less likely to receive prostatectomy, more likely to receive radiation, and much more likely to receive androgen deprivation monotherapy.[26] Over time, utilization of androgen deprivation in particular has increased for high-risk men.[6, 26] Although several large centers have recently reported outcomes of prostatectomy in high risk patients which compare favorably to those from older series,[27] there are no indications that these findings have yet impacted community practice.

These trends have not been evidence-driven; indeed, given the existing dearth of high-quality comparative data, the Institute of Medicine recently included treatment for localized prostate cancer among the 25 most important topics for comparative effectiveness research.[28] Only three randomized trials have been published comparing major primary management approaches. Bill-Axelson et al found a survival benefit for prostatectomy over watchful waiting, with a 35% relative reduction in risk of CSM at 10 years.[29] An older, smaller randomized study likewise reported longer overall survival for prostatectomy patients compared to watchful waiting patients.[30] Another recent trial randomized patients with cT3N0M0 disease to flutamide with or without radiation therapy. The study found a strong benefit for the combination treatment arm,[31] though flutamide monotherapy would generally be considered inadequate therapy by contemporary standards, particularly for locally advanced disease.

Randomized trials in localized prostate cancer face challenges related to high costs associated with long followup and patient and/or clinician biases *a priori* in favour of one approach or another. The Surgical Prostatectomy Versus Interstitial Radiation Intervention Trial (SPIRIT) trial intended to randomize men to radical prostatectomy vs brachytherapy. Despite a 90 minute patient educational session intended to facilitate accrual, only 56 patients accrued at 31 centers over two years, and the study was closed early.[32] The Prostate cancer Intervention Versus Observation Trial (PIVOT) screened 13,022 men at 52 sites over 7 years to identify 5023 eligible men, of whom 731 (14.5%) agreed to be randomized between surgery and observation. Initial results are expected later this year.[33] The Prostate testing for cancer and Treatment (ProtecT) study is the only ongoing randomized trial including more than one active treatment arm—prostatectomy, external-beam radiation, and watchful waiting. It has had greater success attributed to a complex intervention aimed to increase acceptance of randomization.[34] Results will require years, however, to reach maturity.

Meanwhile, important insights into outcomes have been gained from research based on large data sources such as Surveillance, Epidemiology and End Results (SEER) and Medicare.[35,

36 However, these analyses are limited by relatively scant clinical information in the datasets—for example, absent PSA, Gleason, and treatment details. Therefore, prospective disease registries provide an important source of evidence for comparative effectiveness research analyses.37 We performed such an analysis in CaPSURE, a large, national, community-based registry of men followed prospectively and uniformly from diagnosis regardless of treatment selection.

The present analysis finds evidence for significant CSM and ACM differences across primary treatments, controlling for age, disease risk, and comorbidity. Especially striking is the progressive increase in differences across treatments with increasing risk (figure 2 and table 3). Mortality at 10 years is uncommon among men with low-risk disease regardless of treatment, whereas among those with higher risk disease—in contrast to observed treatment trends26—men receiving prostatectomy are much less likely to die than those receiving external-beam radiation, and men in both local therapy groups have better survival than those receiving androgen deprivation alone.

Several caveats should be considered. CaPSURE practice sites are not a random sample of the U.S. population. However, they represent a range of practice locations, sizes, and treatment patterns, and do approximate the community prostate cancer patient experience in the U.S..12 CaPSURE patients reaching mortality endpoints are more likely to have been diagnosed earlier, with a sextant biopsy; their likelihood of clinical understaging is thus greater than would be expected for contemporary patients undergoing extended-template biopsy. Therefore the mortality predictions from this analysis may be higher than might be expected in contemporary practice. It is possible that improvements in technique and outcomes among radiation patients have been more pronounced over the past decade than those for surgery patients; however, we found that the survival differences were if anything greater when restricting the analysis to a more contemporary cohort.

CaPSURE does not include consistent data on radiation dose and technique, nor on tertiary Gleason scores. There were insufficient events to control adequately for type and timing of salvage therapies, which are quite variable—reflecting inconsistent community practices in the face of little evidence-based guidance—and have been discussed in detail previously.38 In a recent report from a large academic cohort comparing prostatectomy with radiation under relatively uniform protocols, adjustment for salvage therapy had no impact on the outcomes of the analysis.39

Higher doses of radiation have been associated with a 12% improvement in recurrence-free survival,40 but have not been demonstrated to improve likelihood of CSM or ACM,4 nor have variations in technique such as intensity-modulation. Variation in radiation practice seems unlikely to explain more than a fraction of the results of this analysis. Indeed, the academic series noted above included only radiation patients receiving 81Gy or more. The results were concordant with the present study, with approximately 3-fold reduction in case mix-adjusted rates of metastasis and prostate cancer-specific mortality in the surgery group. 39 CaPSURE does include a large cohort of patients treated with brachytherapy and active surveillance/watchful waiting. However, they generally were diagnosed in the more recent years of the registry, and their followup is not yet sufficiently mature to assess mortality.

Overall, 51% of the external-beam radiation patients in this analysis received neoadjuvant and/or adjuvant androgen deprivation therapy, a proportion similar to the 56% reported in the recent academic series noted above.39 In CaPSURE, likelihood of receiving neoadjuvant therapy together with external-beam radiation for high-risk disease has increased steadily over time.6 Adjustment for neoadjuvant androgen deprivation with radiation therapy did not modify the results, likely because use of neoadjuvant therapy in CaPSURE associates

closely with disease risk: higher risk patients are much more likely to receive neoadjuvant therapy,6 so the impact of neoadjuvant therapy is reflected in the risk-adjustment, and in a model adjusting for risk, likelihood of neoadjuvant therapy is not an independent predictor. The mean duration of therapy was longer than in the academic series (7.9 months in the present cohort vs. 3 to 6 months in the academic cohort).39 A recent analysis of duration of neoadjuvant therapy found a relatively small (<5%) difference in cancer-specific survival for those receiving longer-term therapy, and an overall survival difference only among those with high-grade disease.41 Longer duration of therapy among higher-risk radiation patients in CaPSURE might therefore be expected to improve outcomes.

To address the possibility that our results were affected by differences in death rates from causes other than prostate cancer, we used competing risk regression, with minimal changes in findings. The attribution of CSM may not be accurate in all cases, particularly those ascertained from the National Death Index; however, the findings were seen for both CSM and ACM and were robust to different considerations of risk as well as several other sensitivity analyses. Finally, it is possible that other unmeasured confounding might explain some part of results. The Charlson score, for example, may not adequately reflect differences in comorbidity which could drive treatment decision-making. (A subset of CaPSURE patients have completed a more comprehensive comorbidity evaluation,42 but this group was too small for the present analysis.)

To evaluate the possibility that the limitations discussed—or other sources of unmeasured confounding—may explain the results, we artificially raised the Kattan scores for radical prostatectomy patients, finding that that in the risk-adjusted model the benefit for surgery over radiation persisted until the scores for prostatectomy patients were increased by at least 20 points. In other words, the nomogram would need to systematically underestimate radiation patients' risk of progression relative to surgical patients' by 20 absolute percentage points; thus, a patient undergoing radiation, for example, with a Gleason 3+3, PSA 4.0 ng/ml, stage T1c tumor would have to have the same true risk as a surgical patient with Gleason 3+4, PSA 9.0 ng/ml, stage T2a tumor. Prediction model accuracy in predicting CSM is 80% across multiple treatments,20 and we cannot identify unmeasured confounders which would be expected to have such a large impact on risk-adjusted outcomes. The magnitude of the differences between treatments might be expected to vary with additional adjustment, but a qualitative change in the findings seems very unlikely. An additional strength of this analysis is that the Kattan and CAPRA scoring systems assign different relative weights to the various prognostic factors included, reducing the likelihood that the outcome of the model is dependent on the specific risk stratification system. In the Zelefsky et al study, likewise, different considerations of risk did not substantially modify the outcomes.39

In a multi-institutional, prospective cohort of prostate cancer patients, we found a low overall risk of cancer-specific mortality. After rigorous case-mix adjustment and multiple sensitivity analyses, however, we identified roughly two- and three-fold increases in risk of cancer mortality among those undergoing external-beam radiation or primary androgen deprivation, respectively, compared to those undergoing radical prostatectomy, with the greatest differences seen for higher-risk patients. These findings should be verified with randomized trial data when available, and with longer followup in CaPSURE and other large registries as more men ultimately reach mortality endpoints.

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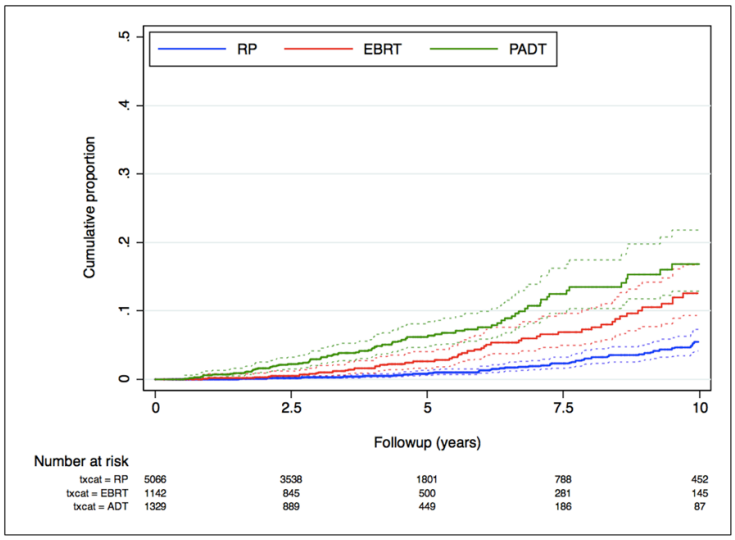

Figure 1.

Unadjusted Kaplan-Meier curves illustrating likelihood of prostate cancer specific mortality by primary treatment: radical prostatectomy (RP), external-beam radiation therapy (EBRT), or primary androgen deprivation therapy (PADT). 95% confidence intervals are given as dashed lines for each treatment.

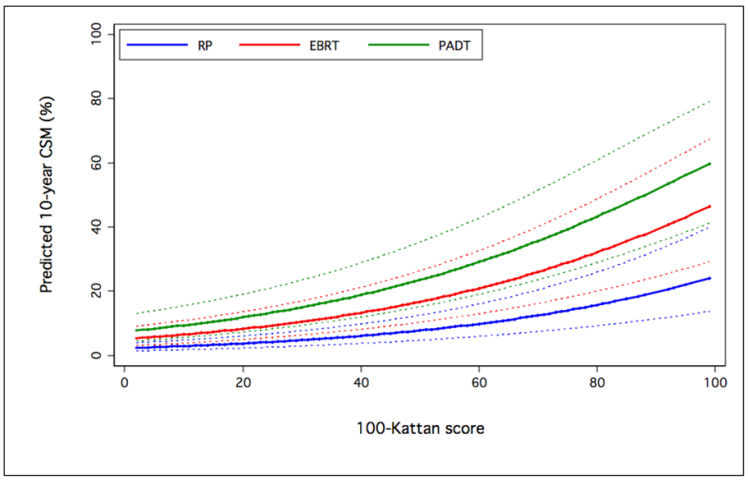

Figure 2.
Predicted 10-year cancer-specific mortality (CSM) following radical prostatectomy (RP), external-beam radiation therapy (EBRT), or primary androgen deprivation therapy (PADT). 95% confidence intervals are given as dashed lines for each treatment.

Table 1

		RP N=5066	EBRT N=1143	PADT N=1329	Total N=7538
Age [median (25%/75% quartile]		62 (56/67)	72 (67/75)	74 (68/79)	65 (59/71)
100-Kattan [median (25%/75% quartile]		15 (9/22)	23 (13/41)	29 (15/54)	17 (10/30)
CAPRA [median (25%/75% quartile]		2 (1/3)	4 (2/6)	4 (2/6)	3 (2/4)
Comorbidities [median (25%/75% quartile]		1 (1/2)	2 (1/3)	2 (1/3)	2 (1/3)
Race	African-American	463 (9.1)	157 (13.7)	197 (14.8)	817 (10.8)
	Caucasian	4439 (87.6)	955 (83.6)	1068 (80.4)	6462 (85.7)
	Other	164 (3.2)	31 (2.7)	64 (4.8)	259 (3.4)
PSA (ng/ml)	0–6	2673 (52.8)	322 (28.2)	301 (22.7)	3296 (43.7)
	6–10	1452 (28.7)	330 (28.9)	355 (26.7)	2137 (28.4)
	10–20	698 (13.8)	302 (26.4)	305 (23.0)	1305 (17.3)
	20–30	129 (2.6)	72 (6.3)	126 (9.5)	327 (4.3)
	>30	114 (2.3)	117 (10.2)	242 (18.2)	4731 (6.3)
Gleason	2–6	3573 (70.5)	619 (54.2)	622 (46.8)	4814 (63.9)
	3+4	850 (16.8)	218 (19.1)	247 (18.6)	1315 (17.4)
	4+3	355 (7.0)	136 (11.9)	175 (13.2)	666 (8.8)
	8–10	288 (5.7)	170 (14.9)	285 (21.4)	743 (9.9)
T stage	T1	2585 (51.0)	484 (42.3)	571 (43.0)	3640 (48.3)
	T2a	1082 (21.4)	249 (21.8)	238 (17.9)	1569 (20.8)
	T2b	392 (7.7)	97 (8.5)	102 (7.7)	591 (7.8)
	T2c	950 (18.8)	266 (23.3)	341 (25.7)	1557 (20.7)
	T3a	57 (1.1)	47 (4.1)	77 (5.8)	181 (2.4)
PPB	≤10%	538 (10.6)	73 (6.4)	125 (9.4)	736 (9.8)
	11–33%	1913 (38.8)	304 (26.6)	337 (25.4)	2554 (33.9)
	34–50%	1367 (27.0)	321 (28.1)	333 (25.1)	2021 (26.8)
	51–75%	490 (9.7)	159 (13.9)	161 (12.1)	810 (10.8)
	>75%	428 (8.5)	200 (17.5)	254 (19.1)	882 (11.7)
	Missing	330 (6.5)	86 (7.5)	119 (9.0)	535 (7.1)
CAPRA	0–2	2735 (54.0)	312 (27.3)	322 (24.2)	3369 (44.7)

		RP N=5066	EBRT N=1143	PADT N=1329	Total N=7538
	3–5	1673 (33.0)	466 (40.8)	471 (35.4)	2610 (34.6)
	6–10	328 (6.5)	279 (24.4)	417 (31.4)	1024 (13.6)
	Missing	316 (6.5)	86 (7.5)	119 (9.0)	535 (7.1)

Table 2

A

	Kattan			CAPRA		
Variable	**HR**	**p**	**95% CI**	**HR**	**p**	**95% CI**
Age	0.98	0.041	0.96–1.00	0.98	0.10	0.96–1.00
Risk points	1.03	<0.001	1.02–1.03	1.40	<0.001	1.31–1.49
RP	Ref			ref		
EBRT	2.21	<0.001	1.50–3.24	1.63	0.017	1.09–2.45
PADT	3.22	<0.001	2.16–4.81	2.65	<0.001	1.75–4.01

B

	Kattan			CAPRA		
Variable	**HR**	**p**	**95% CI**	**HR**	**p**	**95% CI**
Age	1.04	<0.001	1.03–1.05	1.04	<0.001	1.03–1.05
Risk points	1.01	<0.001	1.00–1.01	1.10	<0.001	1.06–1.13
Comorbidity	1.12	<0.001	1.07–1.18	1.12	<0.001	1.06–1.17
RP	Ref					
EBRT	1.59	<0.001	1.33–1.90	1.55	<0.001	1.30–1.86
PADT	2.23	<0.001	1.89–2.75	2.05	<0.001	1.69–2.50

Results of survival analysis for prediction of prostate cancer specific mortality (panel A) and all-cause mortality (panel B). For each variable, hazard ratio (HR) is given with 95% confidence intervals (CI). Risk points refers to the Kattan or Cancer of the Prostate Risk Assessment (CAPRA) scores, respectively. HRs for age, comorbidity count, and risk points are given for each one-year or -point increase, respectively. HRs for external-beam radiation therapy (EBRT) and primary androgen deprivation therapy (PADT) are given relative to radical prostatectomy (RP).

Table 3

	N (%)	RP	EBRT	PADT
CAPRA 0	87 (1.2)	1.57 (0.90, 2.74)	2.19 (1.16, 4.10)	3.38 (1.81, 6.27)
CAPRA 1	1,584 (22.6)	2.19 (1.28, 3.73)	3.04 (1.67, 5.52)	4.70 (2.62, 8.37)
CAPRA 2	1,698 (24.3)	3.04 (1.81, 5.09)	4.23 (2.39, 7.43)	6.50 (3.75, 11.16)
CAPRA 3	1,239 (17.7)	4.23 (2.55, 6.97)	5.86 (3.39, 10.03)	8.97 (5.34, 14.87)
CAPRA 4	778 (11.1)	5.86 (3.56, 9.57)	8.09 (4.77, 13.55)	12.31 (7.53, 19.79)
CAPRA 5	593 (8.5)	8.09 (4.92, 13.16)	11.12 (6.66, 18.28)	16.76 (10.49, 26.20)
CAPRA 6	429 (6.1)	11.12 (6.73, 18.09)	15.19 (9.19, 24.55)	22.61 (14.42, 34.40)
CAPRA 7	312 (4.5)	15.19 (9.12, 24.71)	20.57 (12.53, 32.70)	30.09 (19.53, 44.51)
CAPRA 8	99 (1.4)	20.57 (12.23, 33.38)	27.51 (16.86, 42.88)	39.32 (25.97, 56.34)
CAPRA 9	159 (2.3)	27.50 (16.22, 44.23)	36.19 (22.36, 54.92)	50.20 (33.85, 69.06)
CAPRA 10	25 (0.4)	36.19 (21.25, 56.97)	46.60 (29.17, 68.00)	62.17 (43.10, 81.16)

Predicted 10-year cancer-specific mortality by CAPRA score is given with 95% confidence intervals for each primary treatment: radical prostatectomy (RP), external-beam radiation therapy (EBRT), and primary androgen deprivation therapy (PADT).

Table 4

Increase in Kattan score for RP patients	HR for EBRT	HR for PADT
0	2.21 (1.50–3.24)	3.22 (2.16–4.81)
5	1.95 (1.32–2.88)	2.84 (1.89–4.27)
10	1.72 (1.15–2.55)	2.50 (1.64–3.80)
15	1.51 (1.01–2.27)	2.20 (1.43–3.39)
20	1.33 (0.88–2.02)	1.94 (1.25–3.02)
25	1.17 (0.77–1.80)	1.71 (1.08–2.70)
30	1.03 (0.67–1.61)	1.51 (0.94–2.41)
35	0.91 (0.58–1.44)	1.33 (0.81–2.16)

Hazard ratios (HR) for cancer-specific survival for external-beam radiation therapy (EBRT) and primary androgen deprivation therapy (PADT) relative to radical prostatectomy, controlling for age and Kattan score, with Kattan score for each prostatectomy patient artificially increased by 0 to 35 points.