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Updated Trends in Imaging Use in Men Diagnosed with Prostate Cancer

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Abstract

Background—Previous studies have found persistent over-use of imaging for clinical staging of men with low-risk prostate cancer. We aimed to determine imaging trends in three cohorts of men.

Methods—We analyzed imaging trends of men with prostate cancer who were a part of Cancer of the Prostate Strategic Urologic Research Endeavor CaPSURE (1998–2006), were insured by Medicare (1998–2006), or privately insured (Ingenix database, 2002–2006). The rates of computerized tomography (CT), magnetic resonance imaging (MRI), and bone scan (BS) were determined and time trends were analyzed by linear regression. For men in CaPSURE, demographic and clinical predictors of test use were explored using a multivariable regression model.

Results—Since 1998, there was a significant downward trend in BS (16%) use in the CaPSURE cohort (N=5,156). There were slight downward trends (2.4% and 1.7% respectively) in use of CT and MRI. Among 54,322 Medicare patients, BS, CT, and MRI use increased by 2.1%, 10.8%, and 2.2% and among 16,161 privately insured patients, use increased by 7.9%, 8.9%, and 3.7%, respectively. In CaPSURE, the use of any imaging test was greater in men with higher risk disease. Additionally, type of insurance and treatment affected the use of imaging tests in this population.

Conclusions—There is widespread misuse of imaging tests in men with low-risk prostate cancer, particularly for computerized tomography. These findings highlight the need for examination of factors that drive decision-making with respect to imaging in this setting.

Keywords

prostate cancer; imaging; clinical staging

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Introduction

Few questions in prostate cancer research or clinical care are the subject of so little controversy as the non-utility of staging tests for low-risk prostate cancer. Guidelines dating to the mid-1990s from multiple international organizations have argued—consistently—that tests such as computed tomography (CT) and bone scan (BS) should be limited to men with intermediate- to high-risk disease characteristics, for example prostate specific antigen (PSA) ≥20ng/mL, clinical stage ≥T3, and/or Gleason score ≥7.(1–5)

Downward risk migration during the time since these guidelines were first developed and promulgated has been well documented,(6, 7) and some studies have found a concomitant decline in utilization of imaging tests.(8, 9) However, these studies and others also confirmed persistent over-utilization in substantial proportions of men studied.(8–12) Indeed, a recent study of Medicare beneficiaries with prostate cancer determined that over the past decade, imaging use has increased by 2.5% for nuclear medicine, 4.6% for CT, and 6.2% for magnetic resonance imaging (MRI).(13) Overall, imaging costs within two years of diagnosis have risen by >5% annually and account for a growing portion of prostate cancer expenditures. Additionally, a growing number of studies support concern over the risks of accumulating radiation doses over time and development of secondary malignancies.(14, 15)

We aimed to determine and confirm recently reported trends of imaging utilization in three large, contemporary cohorts of men with various stages of prostate cancer, and to assess demographic and clinical predictors of testing.

Methods

Data registries and study population

The Cancer of the Prostate Strategic Urologic Research Endeavor (CaPSURE™) is a longitudinal, observational database of men with biopsy proven prostate cancer recruited from a total of 40 urologic practice sites. The majority of sites are community based; four university-affiliated and Veterans Affairs (VA) medical centers are included. CaPSURE collects approximately 1,000 clinical and patient reported variables and men are followed until death or study withdrawal. Additional details regarding project methodology have been reported previously.(16) Of 13,821 men registered in the database, 9,333 were diagnosed between 1998 and 2006 and were included in time trends analysis. Of these 5,156 had detailed clinicodemographic data available for multivariate analysis.

The Medicare claims dataset includes information from the Medicare Provider Analysis and Review (MEDPAR) and the National Claims History records, and includes enrollment, claims, and hospitalization data based on the International Classification of Diseases (ICD-9, 9th revision) and procedure codes using the Current Procedural Terminology coding system (4th edition, CPT-4). Medicare does not include clinical information, such as stage or grade, required for tumor risk stratification. Between 1998 and 2006, 77,216 men were diagnosed with prostate cancer via report of both ICD-9 code 185 and CPT codes for either a prostate biopsy or a transurethral resection of the prostate within 180 days of the ICD-9 code report using a 5% Medicare sample. Men under age 66 were excluded, as were those not covered

continuously by Medicare Part A&B (those with Medicare managed care coverage were also excluded). Of the remaining 55,395, 1073 managed primarily with orchiectomy were excluded for presumed metastatic disease, leaving 54,322 in the final cohort.

The i3 database (Ingenix, Salt Lake City, UT) contains medical claims providing use and cost data on privately insured individuals of 75 large employers. Between 2002–2006, 63,150 men were diagnosed with prostate cancer as confirmed by the ICD-9 and CPT codes described above. As with the Medicare cohort, those managed primarily with orchiectomy or chemotherapy were excluded, as were those with discontinuous insurance coverage between the interval from 6 months before to 18 months after primary treatment. 16,161 men met these criteria and were included in the analyses.

Data analysis

Demographic data available for all three cohorts included age, race, place of residence, and primary treatment. Additional clinical information for the CaPSURE cohort included PSA, Gleason grade, clinical stage, insurance type, education level, and household income. For CaPSURE, these clinical variables were used to stratify patients into clinical risk groups using the well-validated Cancer of the Prostate Risk Assessment (CAPRA) score.(17)

Imaging tests in CaPSURE are reported directly by treating clinicians. In the Medicare and i3 databases, CPT codes were searched to identify bone scans (CPT 78306), CT scans (CPT 72192, 72193, 72194), and MRI scans (CPT 72195, 72196, 72197). Imaging utilization for all three tests in all three groups was determined if a test was performed during the staging interval, defined as the period between diagnosis of prostate cancer and date of initial treatment. For men who were not found to have an associated treatment, the staging interval was defined as 180 days following diagnosis. Misclassification of patients undergoing watchful waiting/active surveillance in this category of patients with no treatment was minimized by ensuring there was no evidence of further follow up. Among men who underwent treatment with any form of radiation therapy, pre-treatment dosimetry planning imaging was distinguished from staging imaging via different CPT codes and excluded.

The rates of BS, CT, and MRI were determined in each cohort of men, and time trends were analyzed by linear regression. For men in CaPSURE, demographic and clinical predictors of test utilization were explored using a multivariable regression model. All analyses were performed using Stata statistical software, version 10.1 (StataCorp LP, College Station, Texas).

Results

Table 1 lists comparative demographics for each of the study cohorts. The majority of the patients in all three cohorts were white. The CaPSURE and i3 cohort had similar age distributions, whereas those covered by Medicare were older by definition. The Medicare and i3 populations had greater distributions of patients residing in Southern states as compared with CaPSURE, which had more patients from the Northeast. Table 2 further describes the clinical characteristics available for the CaPSURE cohort. Overall, most men had favorable risk characteristics and clinically localized disease.

Figure 1a depicts time trends in imaging utilization of all three study populations. Since 1998, there was a significant downward trend in BS use within the CaPSURE cohort (−2% per year, −16% overall). However, CT and MRI use had a much smaller downward trend at −0.3% per year, −2.4% overall for CT and −0.2% per year, −1.7% overall for MRI. These trends are mirrored when analysis was restricted to patients with low risk disease only (Figure 1b). Conversely, BS, CT, and MRI use all increased by 0.2%, 1.3%, and 0.2% annually (overall increase 2.1%, 10.8%, 2.2%) in Medicare patients and 1.8%, 2.1%, and 0.8% annually (overall increase 7.9%, 8.9%, and 3.7%) in privately insured patients respectively.

Among CaPSURE patients, when stratified by CAPRA risk group, the use of any imaging test was greater in men with higher risk disease. (Table 3) Treatment type was found to affect the use of imaging modality, with men undergoing brachytherapy and EBRT having significantly greater odds of BS (OR 1.64 and 1.49) and CT (OR 1.72 and 1.39) compared with men treated with ADT (OR 0.42 and 0.53) and WW/AS (0.53 and 0.24) who were less likely to have imaging using either of these modalities. Among men who were imaged with MRI, only those treated with brachytherapy were significantly more likely to undergo imaging (OR 1.83). Additionally, men with Veteran's Affairs coverage were less likely to have BS (OR 0.29) or a CT (OR 0.35). Age at diagnosis, race, level of education, and income were not significantly associated with a specific imaging pattern (data not shown).

Discussion

Imaging studies are performed in men diagnosed with prostate cancer to help provide accurate staging and guide treatment decisions. However, in the era of widespread PSA screening, there has been a profound downward stage migration leading to earlier detection of mostly (80%) clinically localized disease.(18) Bone scan has been shown to have little utility in men with clinically localized disease. In the early 1990s, Osterling et al reported that in over 2,000 men with PSA <20 ng/mL, 0.3% had a positive bone scan.(19) Since that time, this finding has been confirmed by multiple groups.(20–22)

Multiple investigators have likewise affirmed the lack of sensitivity of cross-sectional imaging in determining the extent of disease. Compounded by the low prevalence of detectable lymphadenopathy or nodal metastasis in men with low risk cancer, the predictive value of these tests is quite low, with sensitivity of 36% overall and 25–45% for detecting lymph node metastases. (1, 23, 24)A meta-analysis of 25 studies—including 1,586 men who underwent imaging with staging CT—found that among men with PSA <20ng/mL, CT-documented lymphadenopathy was found in none and identification of localized disease in 0.7%.(20)

MRI was initially thought to be a promising, albeit costly, technology in pre-treatment staging of prostate cancer. Reported rates for sensitivity and specificity in detecting extra-prostatic extension ranges widely from 40–90% and is heavily dependent on clinical setting and local radiologic expertise.(25, 26) Currently, the clinical utility of a routine MRI is unclear in the staging of a low-risk prostate cancer patient, and such testing is in most cases not indicated.

Despite these consistent research findings in large cohorts and well-established practice guidelines, multiple recent studies have repeatedly identified overutilization of imaging in men with low risk disease.(11–13, 27, 28) An initial analysis using CaPSURE data in the 1990s highlighted the widespread overuse in the rates of imaging among patients with low likelihood of non-localized disease.(29) However, a follow-up analysis reporting data through 2001 showed that rates of BS and CT use subsequently decreased dramatically with the greatest decreases (63%) in patients with low-risk disease.(8) In the current analysis, BS use continued to fall, and any imaging test use was appropriately associated with a greater likelihood of higher risk disease. For MRI and CT scan, a weak downward trend continued. A similar trend was observed when restricted to men with only low-risk disease. On the other hand, we found in both men insured by Medicare or privately insured the rates of all imaging tests have increased, with the largest increases in CT scan use (up to 11%). The difference in findings may reflect inherent differences between cohorts. CaPSURE is not a population based cohort and includes relatively high-volume practices which may reflect guideline based practice to a greater extent than the average practitioner represented in Medicare or i3. Further investigation is needed to explore our observed differences.

In another Medicare study, the annual increase of BS, CT, and MRI use for prostate cancer from 1999 to 2006 was 2.5%, 4.6%, and 6.2% respectively, similar to the trends observed in our Medicare and i3 cohorts.(13) A key difference between that paper and the present analysis is that it included any scans ordered within two years of diagnosis, many of which may not have been performed for purposes of staging.

When focusing on the CaPSURE cohort, for whom more detailed clinical data were available, we found that treatment type and VA insurance were predictive of imaging use. Even with adjustment for disease risk, men who were treated with brachytherapy and EBRT had approximately twice the likelihood of undergoing BS and CT than men treated with prostatectomy, echoing our findings in 2002.(8) Men on WW/AS had lower likelihood of BS and CT, as would be expected. Men who were treated with androgen deprivation therapy (ADT) monotherapy also had lower probability of BS and CT. This is somewhat surprising, as men who treated with ADT are more likely to have high-risk disease. One explanation is that men who are not high risk are inappropriately treated with ADT, but appropriately not imaged. Alternatively, high-risk men may be receiving treatment without adequate staging or with the assumption that further imaging would not alter treatment if systemic therapy were administered. Men who elected brachytherapy also had higher odds of MRI imaging.

Another recent cross-sectional analysis of men with newly diagnosed prostate cancer from 2004–2005 using SEER-Medicare linked data parallel our findings of imaging overuse and misuse.(28) Approximately one-third of patients with low risk disease and 48% with intermediate risk disease underwent imaging, compared with only 60% of men with high risk disease. As with the CaPSURE cohort, radiation therapy was significantly associated with a higher odds of imaging (OR 1.71, 95% CI 1.60–1.84), while AS was associated with lower odds of imaging (OR 0.17 95%CI 0.15–0.19). That study did not find a negative association with ADT as in the present analysis, but rather observed increased odds of imaging in men with greater household income. The minor differences in our findings are likely attributable to the differences in patient cohorts and selection.

Interestingly, men who had VA insurance were less likely to have BS and CT imaging in the CaPSURE population. In the VA system, there is no financial incentive for test utilization, which may account for the lower odds of imaging as compared with other insurance groups where reimbursements for diagnostic testing may drive imaging use.(30) This is only one hypothesis to the reason behind inappropriate imaging utilization and further study is needed to determine all factors that lead to misuse. In fact, a recent study including men treated at two Veteran Affairs Hospitals found that 25% of patients with low risk prostate cancer had underwent bone scans, none with positive findings.(27) In the VA study, white men with low risk disease were more likely to have a BS than their black counterparts. Our analysis conversely did not confirm any association between race and overutilization.

Overuse of imaging is associated with significant costs to both the healthcare system and patient safety. In addition to reporting increased utilization of imaging tests in Medicare beneficiaries, Dinan et al showed that imaging costs in patients with prostate cancer have risen at a rate far outstripping that of overall cost of care, increasing annually >5% as compared with a 1.8% rise in total costs.(13) This rate of increase parallels our findings of increased utilization in the Medicare and i3 cohorts. Based on 2012 Medicare reimbursement rates (recently reduced by approximately 25%), an abdominal-pelvic CT (single-phase contrast only) costs approximately $450 (technical fee $356, professional fee $94).(31) If 217,730 men are newly diagnosed with prostate cancer, 50% have low risk disease, and CT imaging occurred in only 20%, an excess of 21,773 tests would be performed. This would translate to nearly $10 million that could be saved yearly, by eliminating unnecessary CT scans alone.

Emerging data regarding risks of radiation exposure and patient safety add further importance to this issue. Smith-Bindman and colleagues recently calculated that radiation doses from abdominal and pelvic CT scans result in a significant attributable risk of subsequent malignancy: for a 60 year old man, 1 cancer would occur among 660–1250 patients who underwent a routine abdominal-pelvic CT scan.(15) Again if 21,773 excess studies are performed yearly using the above estimates, 33 cancers could be prevented simply by eliminating unnecessary CT scans.

Limitations include the retrospective nature of this study as well as specific limitations of each dataset. CaPSURE data primarily reflects tests ordered by urologists; tests ordered by other clinicians will be included only if reported by the urologist and/or by the patient. The Medicare and i3 cohorts do not include parameters with regards to disease risk and we assume that as a group our cohorts have experienced the same downward stage migration as the general population. Some of the imaging tests would have been used appropriately for men with high risk disease. The men in the CaPSURE and i3 study groups were not randomly selected and do not represent a statistical sample of national practice patterns. Additionally, we excluded imaging studies associated with pre-treatment planning in men undergoing some form of radiation therapy by defining staging intervals and utilizing differential CPT and ICD-9 procedure codes. However, a small proportion of men who underwent imaging might have been wrongly classified as “staging” therefore increasing the number of patients in this category.

It is unclear what factors underlie persistent overuse of imaging in men with clinically localized prostate cancer, but possible contributing factors include financial incentives favoring testing, overtesting as a form of “defensive medicine” against fears of malpractice suits, slow dissemination of findings and guidelines to community practitioners, and patient expectations and demands. In fact, the Centers for Medicare and Medicaid’s 2010 Physician Quality Reporting System (PQRS) selected non-utilization of bone scan among low-risk patients as one of only three indicators of high-quality prostate cancer care; reducing unnecessary imaging for low-risk disease is also one of the five initiatives identified in the Choosing Wisely program by the American Urologic Association and the American Board of Internal Medicine foundation.(32, 33) Additionally, Miller et al recently reported on a Urological Surgery Quality Collaborative project centered on improving adherence to imaging guidelines for men newly diagnosed with prostate cancer.(34) Using important quality improvement tools like performance feedback and dissemination of guidelines, a significant reduction in inappropriate use for BS and CT was observed in patients with low and intermediate risk prostate cancer. Eventually, payors may simply stop reimbursing imaging tests in situations such as low-risk prostate cancer in which they clearly are not indicated.

Conclusion

Overutilization of imaging is a remarkably pervasive and persistent phenomenon in localized prostate cancer—verified in this analysis in multiple large datasets and apparently worsening despite the downward risk migration of the disease. The upward trend is greatest for CT, with substantial resulting costs and risks. These findings highlight the need for a re-examination of the financial incentives and other factors that drive decision-making regarding staging test utilization.

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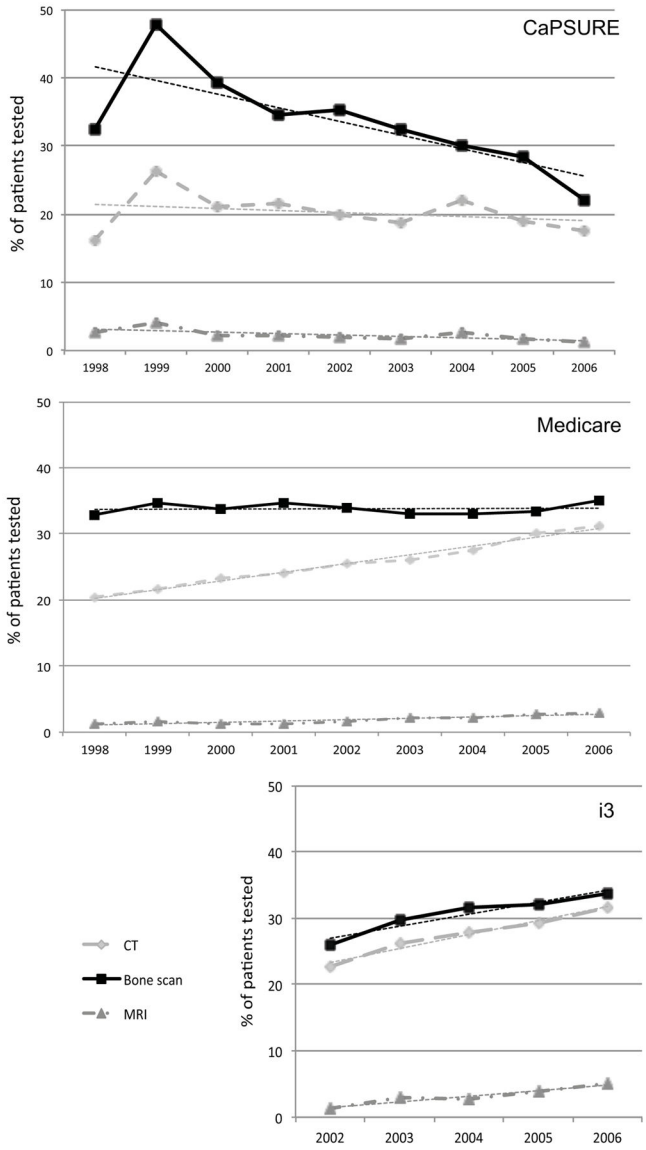
References

1. O’Dowd GJ, Veltri RW, Orozco R, Miller MC, Oesterling JE. Update on the appropriate staging evaluation for newly diagnosed prostate cancer. J Urol. 1997; 158(3 Pt 1):687–98. [PubMed: 9258062]
2. Thompson I, Thrasher JB, Aus G, Burnett AL, Canby-Hagino ED, Cookson MS, et al. Guideline for the management of clinically localized prostate cancer: 2007 update. J Urol. 2007; 177(6):2106–31. [PubMed: 17509297]
3. Greene KL, Albertsen PC, Babaian RJ, Carter HB, Gann PH, Han M, et al. Prostate specific antigen best practice statement: 2009 update. J Urol. 2009; 182(5):2232–41. Epub 2009/09/29. [PubMed: 19781717]
4. Heidenreich A, Bellmunt J, Bolla M, Joniau S, Mason M, Matveev V, et al. EAU Guidelines on Prostate Cancer. Part 1: Screening, Diagnosis, and Treatment of Clinically Localised Disease. Eur Urol. Epub 2010/11/09.
5. Mohler JL. The 2010 NCCN clinical practice guidelines in oncology on prostate cancer. J Natl Compr Canc Netw. 8(2):145. Epub 2010/02/10. [PubMed: 20141674]

6. Cooperberg MR, Lubeck DP, Mehta SS, Carroll PR. Time trends in clinical risk stratification for prostate cancer: implications for outcomes (data from CaPSURE). J Urol. 2003; 170(6 Pt 2):S21–5. discussion S6–7. Epub 2003/11/12. [PubMed: 14610406]
7. Dong F, Reuther AM, Magi-Galluzzi C, Zhou M, Kupelian PA, Klein EA. Pathologic stage migration has slowed in the late PSA era. Urology. 2007; 70(5):839–42. [PubMed: 18068435]
8. Cooperberg MR, Lubeck DP, Grossfeld GD, Mehta SS, Carroll PR. Contemporary trends in imaging test utilization for prostate cancer staging: data from the cancer of the prostate strategic urologic research endeavor. J Urol. 2002; 168(2):491–5. Epub 2002/07/20. [PubMed: 12131295]
9. Chamie K, et al. Bone scan use in the staging of prostate cancer: an analysis of a Veterans Affairs cohort. Urology. in press.
10. Miller DC, Hafez KS, Stewart A, Montie JE, Wei JT. Prostate carcinoma presentation, diagnosis, and staging: an update form the National Cancer Data Base. Cancer. 2003; 98(6):1169–78. Epub 2003/09/16. [PubMed: 12973840]
11. Lavery HJ, Brajtbord JS, Levinson AW, Nabizada-Pace F, Pollard ME, Samadi DB. Unnecessary Imaging for the Staging of Low-Risk Prostate Cancer Is Common. Urology. 2011; 77:274–79. Epub 2010/10/12. [PubMed: 20932557]
12. Choi WW, Williams SB, Gu X, Lipsitz SR, Nguyen PL, Hu JC. Overuse of imaging for staging low risk prostate cancer. J Urol. 185(5):1645–9. Epub 2011/03/23. [PubMed: 21419444]
13. Dinan MA, Curtis LH, Hammill BG, Patz EF Jr, Abernethy AP, Shea AM, et al. Changes in the use and costs of diagnostic imaging among Medicare beneficiaries with cancer, 1999–2006. JAMA. 2010; 303(16):1625–31. Epub 2010/04/29. [PubMed: 20424253]
14. Fazel R, Krumholz HM, Wang Y, Ross JS, Chen J, Ting HH, et al. Exposure to low-dose ionizing radiation from medical imaging procedures. N Engl J Med. 2009; 361(9):849–57. Epub 2009/08/28. [PubMed: 19710483]
15. Smith-Bindman R, Lipson J, Marcus R, Kim KP, Mahesh M, Gould R, et al. Radiation dose associated with common computed tomography examinations and the associated lifetime attributable risk of cancer. Arch Intern Med. 2009; 169(22):2078–86. Epub 2009/12/17. [PubMed: 20008690]
16. Lubeck DP, Litwin MS, Henning JM, Stier DM, Mazonson P, Fisk R, et al. The CaPSURE database: a methodology for clinical practice and research in prostate cancer. CaPSURE Research Panel. Cancer of the Prostate Strategic Urologic Research Endeavor. Urology. 1996; 48(5):773–7. [PubMed: 8911524]
17. Cooperberg MR, Broering JM, Carroll PR. Risk assessment for prostate cancer metastasis and mortality at the time of diagnosis. J Natl Cancer Inst. 2009; 101(12):878–87. Epub 2009/06/11. [PubMed: 19509351]
18. Jemal A, Siegel R, Xu J, Ward E. Cancer statistics, 2010. CA Cancer J Clin. 60(5):277–300. Epub 2010/07/09. [PubMed: 20610543]
19. Oesterling JE. Using PSA to eliminate the staging radionuclide bone scan. Significant economic implications. Urol Clin North Am. 1993; 20(4):705–11. Epub 1993/11/01. [PubMed: 7505979]
20. Abuzallouf S, Dayes I, Lukka H. Baseline staging of newly diagnosed prostate cancer: a summary of the literature. J Urol. 2004; 171(6 Pt 1):2122–7. Epub 2004/05/06. [PubMed: 15126770]
21. Briganti A, Passoni N, Ferrari M, Capitanio U, Suardi N, Gallina A, et al. When to perform bone scan in patients with newly diagnosed prostate cancer: external validation of the currently available guidelines and proposal of a novel risk stratification tool. Eur Urol. 57(4):551–8. Epub 2009/12/26. [PubMed: 20034730]
22. Levran Z, Gonzalez JA, Diokno AC, Jafri SZ, Steinert BW. Are pelvic computed tomography, bone scan and pelvic lymphadenectomy necessary in the staging of prostatic cancer? Br J Urol. 1995; 75(6):778–81. Epub 1995/06/01. [PubMed: 7542138]
23. Cooperberg MR, Pasta DJ, Elkin EP, Litwin MS, Latini DM, Du Chane J, et al. The University of California, San Francisco Cancer of the Prostate Risk Assessment score: a straightforward and reliable preoperative predictor of disease recurrence after radical prostatectomy. J Urol. 2005; 173(6):1938–42. Epub 2005/05/10. [PubMed: 15879786]

24. Reckwitz T, Potter SR, Partin AW. Prediction of locoregional extension and metastatic disease in prostate cancer: a review. World J Urol. 2000; 18(3):165–72. Epub 2000/08/05. [PubMed: 10926079]
25. Brajtbord JS, Lavery HJ, Nabizada-Pace F, Senaratne P, Samadi DB. Endorectal magnetic resonance imaging has limited clinical ability to preoperatively predict pT3 prostate cancer. BJU Int. Epub 2010/09/02.
26. Rorvik J, Halvorsen OJ, Albrektsen G, Ersland L, Daehlin L, Haukaas S. MRI with an endorectal coil for staging of clinically localised prostate cancer prior to radical prostatectomy. Eur Radiol. 1999; 9(1):29–34. Epub 1999/02/05. [PubMed: 9933375]
27. Palvolgyi R, Daskivich TJ, Chamie K, Kwan L, Litwin MS. Bone Scan Overuse in Staging of Prostate Cancer: An Analysis of a Veterans Affairs Cohort. Urology. Epub 2011/04/16.
28. Prasad SM, Gu X, Lipsitz SR, Nguyen PL, Hu JC. Inappropriate utilization of radiographic imaging in men with newly diagnosed prostate cancer in the United States. Cancer. 2012; 118(5): 1260–7. Epub 2011/08/09. [PubMed: 21823112]
29. Kindrick AV, Grossfeld GD, Stier DM, Flanders SC, Henning JM, Carroll PR. Use of imaging tests for staging newly diagnosed prostate cancer: trends from the CaPSURE database. J Urol. 1998; 160(6 Pt 1):2102–6. Epub 1998/11/17. [PubMed: 9817332]
30. Hollingsworth JM, Birkmeyer JD, Zhang YS, Zhang L, Hollenbeck BK. Imaging use among employed and self-employed urologists. J Urol. 184(6):2480–4. Epub 2010/10/19. [PubMed: 20952030]
31. May 11th, 2011]; Available from: https://www.cms.gov
32. Services. CfMaM. [Accessed January 20, 2011] PQRI Measures List. 2010. Available from: https://www.cms.gov/PQRI/Downloads/2010PQRIMeasuresList111309.pdf
33. Available from: http://www.choosingwisely.org/doctor-patient-lists/american-urological-association/
34. Miller DC, Murtagh DS, Suh RS, Knapp PM, Schuster TG, Dunn RL, et al. Regional collaboration to improve radiographic staging practices among men with early stage prostate cancer. J Urol. 2011; 186(3):844–9. Epub 2011/07/27. [PubMed: 21788043]



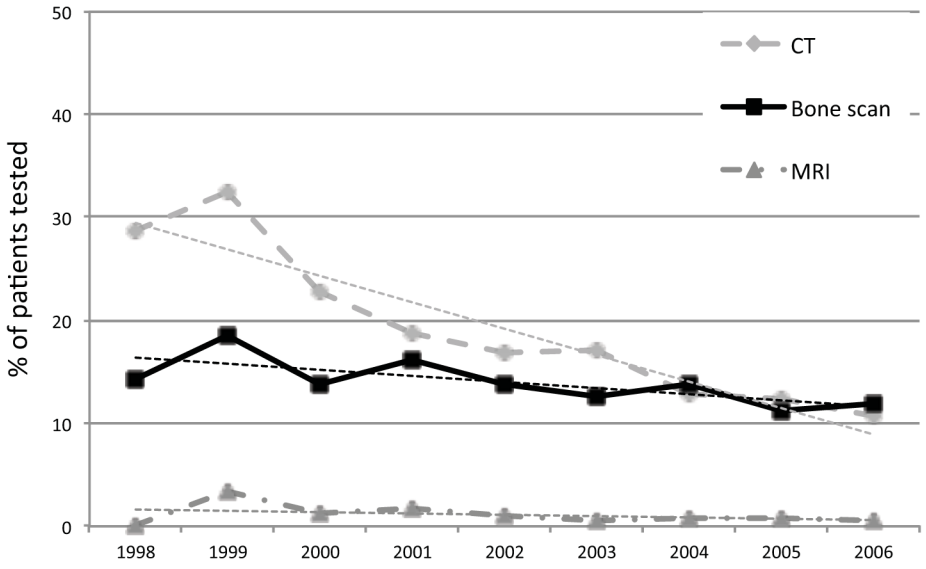


Figure 1.

Table 1

Patient Demographics

	CaPSURE (%)		Medicare (%)		Ingenix (%)	
Age at Diagnosis:						
Younger than 60	1,680	(18)	N/A		5,600	(35)
60–64	2,053	(22)	N/A		3,577	(22)
65–69	1,960	(21)	11,532	(21)	2,222	(14)
70–74	1,867	(20)	16,517	(30)	1,935	(12)
75 or Older	1,773	(19)	26,273	(49)	2,827	(17)
Race:						
White	7,999	(86)	47,313	(87)	11,202	(69)
Black	992	(10)	4,841	(9)	807	(5)
Asian	--	--	547	(1)	183	(1)
Hispanic	144	(2)	1072	(2)	627	(4)
Other	198	(2)	493	(1)	2,289	(14)
Unknown	--	--	56	(0)	1,053	(7)
State of Residence:						
Northeast	4,573	(49)	10,849	(20)	2,094	(13)
South	2,427	(26)	20,376	(38)	6,811	(42)
Midwest	840	(9)	13,739	(25)	5,070	(31)
West	1,493	(16)	8,515	(15)	2,173	(14)
Other*		--	843	(2)	13	(0)
Primary Treatment:						
RP	4,221	(45)	5,132	(10)	5,030	(31)
EBRT	802	(9)	12,519	(23)	2,629	(16)
Brachytherapy	1,410	(15)	3,838	(7)	1,269	(8)
Cryotherapy	303	(3)	271	(1)	66	(1)
ADT	1,345	(14)	8,554	(16)	1,040	(6)

	CaPSURE (%)		Medicare (%)		Ingenix (%)	
WW/AS	520	(6)	7,287	(14)	1,400	(9)
None/Other	732	(8)	16,381	(29)	4,571	(29)

* Puerto Rico, Guam, etc.

RP- Radical Prostatectomy, EBRT- External Beam Radiation Therapy, ADT- Androgen Deprivation Therapy, WW/AS- Watchful Waiting, Active Surveillance

Table 2

Clinical Characteristics of the CaPSURE Cohort

	Total No.	(%)
PSA (ng/mL):		
0–10	6,906	(74)
10.01–20	1,230	(13)
20.01–30	267	(3)
Greater than 30	428	(5)
Unknown	502	(5)
Gleason Sum:		
2–6	5,657	(61)
3+4	1,620	(17)
4+3	895	(10)
8–10	901	(9)
Unknown	260	(3)
Clinical T stage:		
T1	5,063	(54)
T2 a/b	1,944	(21)
T2c	1,415	(15)
T3a	121	(1)
T3b-T4	79	(1)
Unknown	711	(8)
Risk Group (CAPRA):		
0–2	4,342	(47)
3–5	2,527	(27)
6–10	980	(11)
Unknown	1,484	(15)
Insurance Type:		
Medicare	4,196	(45)
Private	4,252	(46)
Veterans Affairs	286	(3)
Other	599	(6)
Income Level ($):		
<5k	94	(1)
5–10k	160	(2)
10–20k	578	(6)
20–30k	896	(10)

	Total No.	(%)
30–50k	1,407	(15)
50–75k	1,126	(12)
>75k	1,653	(18)
Unknown	3,419	(36)
Education Level:		
No High School	342	(4)
Some High School	601	(6)
High School Graduate	1,740	(19)
Some College	1,284	(14)
College Graduate	1,192	(12)
Graduate School	1,392	(15)
Unknown	2,782	(30)

Table 3

Demographic and Clinical Factors Predictive of Imaging Utilization in the CaPSURE Cohort

	BS		CT		MRI	
	OR (95%CI)	**p-value**	**OR (95%CI)**	**p-value**	**OR (95%CI)**	**p-value**
Risk:						
CAPRA Score	1.57 (1.51–1.63)	<**0.001**	1.27 (1.22–1.31)	<**0.001**	1.38 (1.26–1.50)	<**0.001**
Treatment:						
RP	referent					
Cryotherapy	0.96 (0.69–1.36)	0.849	0.87 (0.60–1.28)	0.490	0.62 (0.15–2.67)	0.525
Brachytherapy	1.64 (1.36–1.97)	<**0.001**	1.72 (1.40–2.09)	<**0.001**	1.83 (1.11–3.04)	**0.018**
EBRT	1.49 (1.17–1.92)	**0.001**	1.39 (1.07–1.79)	**0.013**	0.75 (0.33–1.70)	0.498
ADT	0.42 (0.33–0.54)	<**0.001**	0.53 (0.40–0.69)	<**0.001**	0.73 (0.35–1.52)	0.409
WW/AS	0.31 (0.21–0.47)	<**0.001**	0.24 (0.14–0.44)	<**0.001**	1.37 (0.45–4.09)	0.575
Insurance Type:						
Medicare Plus*	referent					
Medicare	0.87 (0.71–1.07)	0.192	0.85 (0.68–1.06)	0.148	0.73 (0.34–1.57)	0.419
Private	0.92 (0.78–1.11)	0.398	0.98 (0.77–1.11)	0.834	1.67 (0.96–2.92)	0.070
Veterans Affairs	0.29 (0.18–0.47)	<**0.001**	0.35 (0.20–0.61)	<**0.001**	0.96 (0.27–3.34)	0.955

*Medicare plus= Medicare + supplemental insurance