NCCN National Comprehensive Cancer Network®

## NCCN Clinical Practice Guidelines in Oncology (NCCN Guidelines®)

# Prostate Cancer

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NCCN Guidelines Panel Disclosures

**Clinical Trials:** NCCN believes that the best management for any patient with cancer is in a clinical trial.
Participation in clinical trials is especially encouraged.

To find clinical trials online at NCCN Member Institutions, click here:nccn.org/clinical_trials/clinicians.aspx.

**NCCN Categories of Evidence and Consensus:** All recommendations are category 2A unless otherwise indicated.

See NCCN Categories of Evidence and Consensus.

## Updates in Version 4.2019 of the NCCN Guidelines for Prostate Cancer from Version 3.2019 include:

**Discussion**
- The Discussion section was updated to reflect the changes in the algorithm.

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## Updates in Version 3.2019 of the NCCN Guidelines for Prostate Cancer from Version 2.2019 include:

**PROS-14**
- Systemic therapy for castration-naive disease:
  - Added *apalutamide* as a (category 1) option for M1 prostate cancer.
  - Added *enzalutamide* as a (category 1) option for M1 prostate cancer.

**PROS-15**
- Systemic therapy for M0 castration-resistant prostate cancer (CRPC):
  - Added *darolutamide* as a (category 1) option for patients with PSADT ≤10 mo.

**PROS-F (2 of 5)**
- Modified treatment options for men with M1 castration-naive disease:
  - Orchiectomy plus abiraterone, *enzalutamide, or apalutamide*
  - LHRH agonist (as above) plus abiraterone, *enzalutamide, or apalutamide*
  - LHRH antagonist (as above) plus abiraterone, *enzalutamide, or apalutamide*

**PROS-F (3 of 5)**
- Added the following 3 new bullets:
  - Two randomized phase 3 clinical trials of abiraterone with prednisone plus ADT in men with castration-naïve metastatic prostate cancer demonstrated improved OS over ADT alone. Adverse events were higher with abiraterone and prednisone but were generally mild in nature and were largely related to mineralocorticoid excess (ie, hypertension, hypokalemia, edema), hormonal effects (ie, fatigue, hot flushes), and liver toxicity. Cardiac events, severe hypertension, and liver toxicity were increased with abiraterone.
  - A double-blind randomized phase 3 clinical trial of apalutamide plus ADT in men with castration-naïve metastatic prostate cancer demonstrated improved OS over ADT alone. Adverse events that were more common with apalutamide than with placebo included rash, hypothyroidism, and ischemic heart disease.
  - An open-label randomized phase 3 clinical trial of enzalutamide plus ADT in men with castration-naïve metastatic prostate cancer demonstrated improved OS over ADT alone. In a separate double-blind randomized phase 3 clinical, enzalutamide reduced the risk of metastatic progression or death compared with placebo. Adverse events associated with enzalutamide included fatigue, seizures, and hypertension.
- Added *darolutamide (for M0 and PSADT ≤10 mo).*
- Added a new bullet: *A phase 3 study of patients with M0 CRPC and a PSADT ≤10 mo showed darolutamide (600 mg twice daily) improved the primary endpoint of metastasis-free survival over placebo (40.4 mo vs. 18.4 mo). An improvement in overall survival was seen at the first interim analysis (HR for death, 0.71; 95% CI, 0.50-0.99; P = .045), although these data are immature (median survival was not reached in either arm). Adverse events that occurred more frequently in the treatment arm included fatigue (12.1% vs. 8.7%), pain in an extremity (5.8% vs. 3.2%), and rash (2.9% vs. 0.9%). The incidence of fractures was similar between darolutamide and placebo (4.2% vs. 3.6%).*

## Updates in Version 2.2019 of the NCCN Guidelines for Prostate Cancer from Version 1.2019 include:

**PROS-F (1 of 5)**
- Changed the dosing frequency of prednisone from "twice daily" to "once daily": Abiraterone should be given with concurrent steroid, either prednisone 5 mg orally ~~twice~~ *once* daily or methylprednisolone 4 mg orally twice daily depending on the formulation of abiraterone used (category 2B for abiraterone with methylprednisolone).

**MS-1**

The Discussion section has been updated based on changes to the algorithm.

## Updates in Version 1.2019 of the NCCN Guidelines for Prostate Cancer from Version 4.2018 include:

**PROS-1**
- This page was extensively revised to include recommendations regarding germline genetic testing.

**PROS-2**
- Changed the title of this page to *Initial* Risk Stratification And Staging Workup *For Clinically Localized Disease*.
- Moved recommendations for Regional and Metastatic risk groups to page PROS-9.
- Changed column heading to Molecular ~~testing~~ and *biomarker analysis* of tumor.
- Very low, low, and intermediate risk groups, changed the germline testing recommendation from Consider if strong family history to *Recommended if family history positive or intraductal histology.*
- Clarified the clinical/pathologic criteria for favorable and unfavorable intermediate risk groups.
- High and very high risk groups, changed the germline testing recommendation from Consider to *Recommended*.

**PROS-3**
- Footnote c is new: Family history for known germline variants and genetic testing for germline variants should include *MLH1, MSH2, MSH6*, and *PMS2* (for Lynch syndrome) and homologous recombination genes *BRCA1, BRCA2, ATM, PALB2,* and *CHEK2.* Consider cancer predisposition NGS panel testing, which includes *BRCA2, BRCA1, ATM, CHEK2, PALB2, MLH1, MSH2, MSH6*, and *PMS2.* Additional genes may be appropriate depending on clinical context. For example, *HOXB13* is a prostate cancer risk gene that does not have clear therapeutic implications in advanced disease, but testing may be valuable for family counseling.
- Footnote f was modified: For asymptomatic patients *in very low, low, and intermediate risk groups* with life expectancy ≤5 years, no further workup or treatment is indicated until the patient becomes symptomatic.
- Footnote g was modified: *An ultrasound- or MRI- or DRE-targeted lesion that is biopsied more than once and demonstrates cancer (regardless of percentage core involvement or number of cores involved) counts as a single positive core.* ~~Patients with a MRI lesion that is biopsied and demonstrates grade group 1 cancer (regardless of percentage core involvement or number of cores involved) who otherwise qualify for very low risk should be considered very low risk.~~
- Footnote k was modified: *The prevalence of inherited (germline) DNA repair gene mutations in men with metastatic prostate cancer, unselected for family history (n = 692), was found to be 11.8% (BRCA2 5.3%, ATM 1.6%, CHEK2 1.9%, BRCA1 0.9%, RAD51D 0.4%, and PALB2 0.4%), and 6% in the localized high-risk population in the TCGA cohort (Cancer Genome Atlas Research Network. The molecular taxonomy of primary prostate cancer. Cell 2015;163:1011-25; Pritchard CC, Mateo J, Walsh MF, et al. Inherited DNA-repair gene mutations in men with metastatic prostate cancer. N Engl J Med 2016;375:443-453). Germline genetic testing is recommended for all men with high risk, very high risk, regional, or metastatic prostate cancer. Genetic counseling resources and support is critical and pre-test counseling is preferred when feasible. Post-test genetic counseling is recommended if a mutation is identified.*
~~The prevalence of inherited homologous recombination gene mutations in men with metastatic or localized high risk was found to be 11.8% and 6.0%, respectively.Therefore, germline genetic testing and genetic counseling should be considered in all men with high risk, very high risk, regional,~~

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## Updates in Version 1.2019 of the NCCN Guidelines for Prostate Cancer from Version 4.2018 include:

~~or metastatic prostate cancer. Pritchard CC, Mateo J, Walsh MF, et al. Inherited DNA-repair gene mutations in men with metastatic prostate cancer. N Engl J Med 2016;375:443-453.~~

- Footnote l is new: Patients should be informed that somatic tumor sequencing has the potential to uncover germline findings. However, virtually none of the NGS tests are designed or validated for germline assessment. Therefore, over-interpretation of germline findings should be avoided. If a germline mutation is suspected, the patient should be recommended for genetic counseling and follow-up dedicated germline testing. (also applies to PROS-9)
- Footnote j was modified: Plain films, CT, MRI, F-18 sodium fluoride PET/CT *or PET/MRI, C-11 choline PET/CT or PET/MRI, or F-18 fluciclovine PET/CT or PET/MRI* can be considered for equivocal results on initial bone scan. See PROS-B.
- Footnote m was modified: Men with low or favorable intermediate risk disease may consider the use of the following tumor-based molecular assays: Decipher, Oncotype DX Prostate, Prolaris, and ProMark. Retrospective studies have shown that molecular assays performed on prostate biopsy or radical prostatectomy specimens provide prognostic information independent of NCCN *or CAPRA* risk groups. These include, but are not limited to, likelihood of death with conservative management, likelihood of biochemical progression after radical prostatectomy or external beam therapy, and likelihood of developing metastasis after radical prostatectomy or salvage radiotherapy. See Discussion.

PROS-4

- Very low risk group, ≥20 y expected patient survival:
  - Changed the recommendation for Active surveillance to *preferred.*
  - Changed: Radical prostatectomy (RP)[r] ~~± pelvic lymph node dissection (PLND) if predicted probability of lymph node metastasis ≥2%~~ (also applies to PROS-5).
- Adjuvant therapy
  - Adverse features, EBRT: added ± *ADT (6 mo)* (also applies to PROS-5 through PROS-8).
  - No adverse features, removed ~~or lymph node metastases~~ (also applies to PROS-5).
  - Removed: Lymph node metastasis: ADT (category 1) ± EBRT (category 2B) or Observation (also applies to PROS-5)
- Active Surveillance recommendations were changed as follows (also applies to PROS-5, and -6):
  - Added: *Consider mpMRI and/or prostate biopsy to confirm candidacy for active surveillance.*
  - Changed: ~~Consider~~ *Repeat* mpMRI *no more often than every 12 mo unless clinically indicated* ~~if anterior and/or aggressive cancer is suspected when PSA increases and systematic prostate biopsies are negative.~~

PROS-6

- Favorable intermediate risk group, initial therapy, <10 y expected patient survival:
  - Observation is *preferred.*
- Modified footnote x: PSA nadir is the lowest value reached *after RT.*

PROS-7

- Unfavorable intermediate risk group:
  - Initial therapy, changed from EBRT + ADT (4–6 mo) to EBRT ± ADT (4 mo)
  - Initial therapy, changed: EBRT + brachytherapy ± ADT (4-6 mo) to ± ADT (4 mo)
- For <10 y expected patient survival:
  - Observation is *preferred.*

PROS-8

- High or very high risk group:
  - Expected patient survival >5 y
    - ◊ Added *or symptomatic*
    - ◊ EBRT + ADT, changed ADT from "2-3 y; category 1" to "*1.5–3 y; category 1 for ADT*"
    - ◊ Modified EBRT + brachytherapy + ADT (1–3 y: category 1 *for ADT)*
  - Added a treatment branch for expected patient survival ≤5 y and asymptomatic (recommendations were previously on PROS-1).
  - Footnote cc is new: Androgen deprivation therapy (ADT) or radiation therapy (RT) may be considered in selected patients with high- or very-high-risk disease, where complications, such as hydronephrosis or metastasis, can be expected within 5 y.
- Removed footnote: Six cycles of docetaxel every 3 weeks with concurrent steroid may be administered after completion of radiation in selected patients who are fit for chemotherapy.

PROS-9

- This page is new to the guidelines; the recommendations were previously

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## Updates in Version 1.2019 of the NCCN Guidelines for Prostate Cancer from Version 4.2018 include:

on page PROS-2.
- Changed the germline testing recommendation from Consider to *Recommended*.
- Footnotes dd and ee were modified:
  - DNA analysis for MSI and IHC for MMR are different assays measuring the same biological effect. *If MSI is used, testing using an NGS assay validated for prostate cancer is preferred.* If MSI-H or dMMR is found, refer to genetic counseling to assess for the possibility of Lynch syndrome. MSI-H or dMMR indicate eligibility for pembrolizumab in later lines of treatment for CRPC (see PROS-17 and PROS-18). *Hempelmann JA, Lockwood CM, Konnick EQ, et al. Microsatellite instability in prostate cancer by PCR or NGS. J Immunother Cancer 2018;6:29.*
  - *Consider evaluating tumor for alterations in homologous recombination DNA repair such as: BRCA1, BRCA2, ATM, PALB2, FANCA, RAD51D, and CHEK2.* ~~Consider testing for mutation in these genes (germline and somatic): BRCA1, BRCA2, ATM, PALB2, FANCA; refer to genetic counseling if positive~~. At present, this information may be used for genetic counseling, early use of platinum chemotherapy, and/or eligibility for clinical trials (eg, PARP inhibitors). *Clinical trials may include additional candidate DNA repair genes under investigation as molecular biomarkers. If mutations in BRCA2, BRCA1, ATM, CHEK2, or PALB2 are found and/or there is a strong family history of cancer, refer to genetic counseling to assess for the possibility of hereditary breast and ovarian cancer (HBOC)* ~~At present, this information may be used for genetic counseling, early use of platinum chemotherapy, or eligibility for clinical trials (e.g., PARP inhibitors).~~
- Footnote ff is new: ADT alone (see PROS-F) or observation is recommended for asymptomatic patients with metastatic disease and life expectancy ≤5 years. (These recommendations were previously on PROS-1).

PROS-10
- Regional risk group:
  - Expected patient survival >5y
    - ◊ Added *or symptomatic*
    - ◊ EBRT + ADT, changed ADT from "2–3 y; category 1" to "*preferred*"
    - ◊ Removed *"(2–3 y; category 1)"* from ADT recommendations
  - Added a treatment branch for expected patient survival ≤5 y and asymptomatic. These recommendations were previously on PROS-1.

PROS-11
- N1 on ADT or Localized on observation, changed physical exam + PSA very ~~3~~-*6 mo.*
- Footnote hh was modified: Workup for progression should include ~~chest x-ray or chest CT,~~ bone imaging, *chest CT*, and abdominal/pelvic CT or *abdominal/pelvic* MRI with and without contrast. Consider C-11 choline PET/CT or PET/MRI or F-18 fluciclovine PET/CT or PET/MRI for further soft tissue *and bone* evaluation or F-18 sodium fluoride PET/CT *or PET/MRI* for further bone evaluation. *The Panel remains unsure what to do when M1 is suggested by modern imaging but not on conventional imaging.* See Principles of Imaging (PROS-B) and Discussion. (Also applies to PROS-12, -13, -14, and -15).

PROS-12
- Radical prostatectomy PSA persistence/recurrence:
  - Added Risk stratification with PSADT
  - Consider:
    - ◊ ~~Chest x-ray or~~ *Chest CT* (also applies to PROS-13).
    - ◊ Abdominal/pelvic CT or *abdominal/pelvic* MRI ~~and/or TRUS~~ (also applies to PROS-13)
    - ◊ C-11 choline or F-18 fluciclovine PET/CT or PET/MRI
    - ◊ ~~Decipher molecular assay (category 2B)~~
- Treatment options for Studies positive for distant metastases were removed from the page. A link to PROS-14 was added instead.
- Footnote ll is new: PSADT can be calculated to inform nomogram use and counseling and/or Decipher molecular assay (category 2B) can be considered to inform counseling.
- Footnote mm was modified: F-18 sodium fluoride *or C-11 choline or F-18 fluciclovine* PET/CT *or PET/MRI* can be considered after bone scan for further evaluation when clinical suspicion of bone metastases is high. (Also applies to PROS-13)

PROS-13
- Radiation therapy recurrence:
  - Added Risk stratification with PSADT
  - Removed "or clinical trial" because it is already stated on the bottom of the page.
  - Changed recommendations for chest imaging: *Consider* ~~chest x-ray or~~ Chest CT
- Footnote oo is new: PSADT can be calculated to inform nomogram use and counseling.

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**Updates in Version 1.2019 of the NCCN Guidelines for Prostate Cancer from Version 4.2018 include:**

**PROS-14**
- Recommendations for ADT were removed from the page. They can be found in the Principles of Androgen Deprivation Therapy (PROS-F).
- Systemic therapy for castration-naive disease:
  - M0: Changed observation to *preferred*.
  - M1, added options for *ADT and EBRT to the primary tumor for low volume M1.*
- Footnote pp is new: EBRT to sites of metastases can be considered if metastases are in weight-bearing bones or if the patient is symptomatic.
- Footnote qq is new: ADT alone (see PROS-F) or observation are recommended for asymptomatic patients with metastatic disease and life expectancy ≤5 years. (These recommendations were previously on PROS-1).

**PROS-15**
- Systemic therapy for M0 castration-resistant prostate cancer (CRPC):
  - Modified *Conventional imaging* studies negative for distant metastases.
  - Added separate branches for *PSADT > 10 mo* and *PSADT ≤10 mo.*

**PROS-16**
- Systemic therapy for M1 CRPC:
  - Added a new bullet: Consider metastatic lesion biopsy.
  - Added a treatment branch for small cell/neuroendocrine prostate cancer These treatment recommendations were previously on PROS-18.
- Modified: Bone antiresorptive therapy with denosumab (*category 1, preferred*) or zoledronic acid ~~(both category 1)~~ if bone metastases present.
- Modified footnote ww: Sipuleucel-T has not been studied in patients with visceral metastases. *Sipuleucel-T is not recommended for patients with small cell/neuroendocrine prostate cancer.*

**PROS-17**
- Modified page title: ~~Subsequent~~ Systemic therapy for M1 CRPC: *Adenocarcinoma Without Visceral Metastases.*
- Added column headings for *first-line, second-line*, and *subsequent treatment.*
- Modified footnote ccc: ~~Limited data suggest a possible role for~~ *Consider* AR-V7 testing to help guide selection of therapy (See Discussion). (Also applies to PROS-18)
- Footnote ddd is new: Workup for progression should include chest CT, bone imaging, and abdominal/pelvic CT or abdominal/pelvic MRI with and without contrast. Consider metastatic lesion biopsy. See Principles of Imaging (PROS-B) and Discussion. (Also applies to PROS-18)
- Footnote eee is new*:* If visceral mets are found, see PROS-18. If small cell neuroendocrine is found, see PROS-16.

**PROS-18**
- Modified page title: Systemic therapy for M1 CRPC: *Adenocarcinoma with Visceral Metastases.*
- Added column headings for *first-line, second-line*, and *subsequent treatment.*
- Treatment recommendations for subsequent treatment were added. All are category 2B (excluding clinical trial and best supportive care).
- Footnote hhh was modified: Patients treated with *first-line* systemic therapy for non-visceral metastases (see PROS-17) should proceed to a different subsequent therapy *for patients with visceral metastases based on their previous treatment. If small cell neuroendocrine is found, see PROS-16.*

**PROS-B**
- Principles of imaging
  - Bone imaging, modified:
    - ◊ F-18 sodium fluoride PET/CT *or PET/MRI* may be used to detect bone metastatic disease with greater sensitivity but less specificity than standard bone scan imaging.
    - ◊ Plain films, CT, MRI, F-18 sodium fluoride PET/CT *or PET/MRI, C-11 choline PET/CT or PET/MRI, or F-18 fluciclovine PET/CT or PET/MRI* can be considered for equivocal results on initial bone scan.
  - Modified heading: Positron Emission Tomography~~/Computed Tomography~~ (PET~~/CT~~)
    - ◊ Modified: C-11 choline or F-18 fluciclovine PET/CT or PET/MRI may be used to detect small volume disease in soft tissues *and in bone.*
    - ◊ Removed: Performance is generally poor at low PSA where pre-test probability of disease is low (PSA <2.0 ng/ml) and where salvage treatment is most likely to be beneficial.PROS-C
- Principles of Active Surveillance and Observation
  - Modified: Active surveillance is preferred for men with very-low-risk prostate cancer and life expectancy ≥20 y *and for men with low-risk prostate cancer and life expectancy ≥10 y*. Observation is preferred for men with low-risk prostate cancer with life expectancy <10 y.
  - Removed "(predominant Gleason grade 3 [ie, Gleason score 3 + 4 = 7], and percentage of positive biopsy cores <50 percent, and no more than

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**Updates in Version 1.2019 of the NCCN Guidelines for Prostate Cancer from Version 4.2018 include:**

one NCCN intermediate risk factor)" and added "*(See Risk Group Criteria [PROS-2])*."
  - Updated Active Surveillance recommendations to match changes in the algorithm.
  - Removed: Although mpMRI is not recommended for routine use, it may be considered if PSA rises and systematic prostate biopsy is negative to exclude the presence of an anterior cancer.
  - A bullet was modified: A repeat prostate biopsy should be considered *no more often then* ~~as often as~~ annually to assess for disease progression, because PSA kinetics may not be as reliable *for predicting progression* ~~as monitoring parameters to determine progression of disease~~.

PROS-D (1 of 5)
- Definitive radiation therapy for low risk group, added *Men with NCCN low-risk prostate cancer are encouraged to pursue active surveillance.*

PROS-D (2 of 5)
- Added a new section: Low-volume metastatic disease
  - Radiation therapy to the prostate is an option in patients with low-volume castration-naive metastatic disease, without contraindications to radiotherapy. ADT is required unless medically contraindicated.
  - This recommendation is based on the STAMPEDE phase 3 randomized trial, which randomized 2,061 men to standard systemic therapy with or without radiotherapy to the primary. The overall cohort had a significant improvement from the addition of radiotherapy to the primary in failure-free survival, but not overall survival. The prespecified low-volume subset had a significant improvement in both failure-free survival and overall survival.
  - Minimizing toxicity is paramount when delivering radiation therapy to the primary in patients with metastatic disease.
  - Whether treatment of regional nodes in addition to the primary improves outcomes remains uncertain; nodal treatment should be performed in the context of a clinical trial.
  - Dose escalation beyond biologically effective dose equivalents of the two dose prescriptions used in STAMPEDE (55 Gy in 20 fractions or 6 Gy x 6 fractions) is not recommended given the known increase in toxicity from dose intensification without overall survival improvement in localized disease.
  - Brachytherapy is not recommended outside of a clinical trial as safety and efficacy have not been established in this patient population.
- Added a new section: High-volume metastatic disease
  - Radiation therapy to the prostate should NOT be performed in men with high-volume metastatic disease outside the context of a clinical trial unless for palliative intent.
  - This recommendation is based on two randomized trials, HORRAD and STAMPEDE, neither of which showed an improvement in overall survival from the addition of radiotherapy to the primary when combined with standard systemic therapy.

PROS-D (3 of 5)
- Revised the table to be consistent with the algorithm.

PROS-D (4 of 5)
- Modified *EBRT with* two years of anti-androgen therapy with 150 mg/daily of bicalutamide ~~(RTOG 9601) or 6 months of ADT (GETUG-16) have both~~ demonstrated improved overall and metastasis-free survival on *a* prospective randomized trial *(RTOG 9601)* versus radiation alone in the salvage setting. *EBRT with 6 months of ADT improved biochemical or clinical progression at 5 years on a prospective randomized trial (GETUG-16) versus radiation alone.*

PROS-E
- Radical prostatectomy, modified Blood loss can be substantial with RP, but can be reduced by *using laparoscopic or robotic assistance or by* careful control of the dorsal vein complex and periprostatic vessels *when performed open.*

Continued

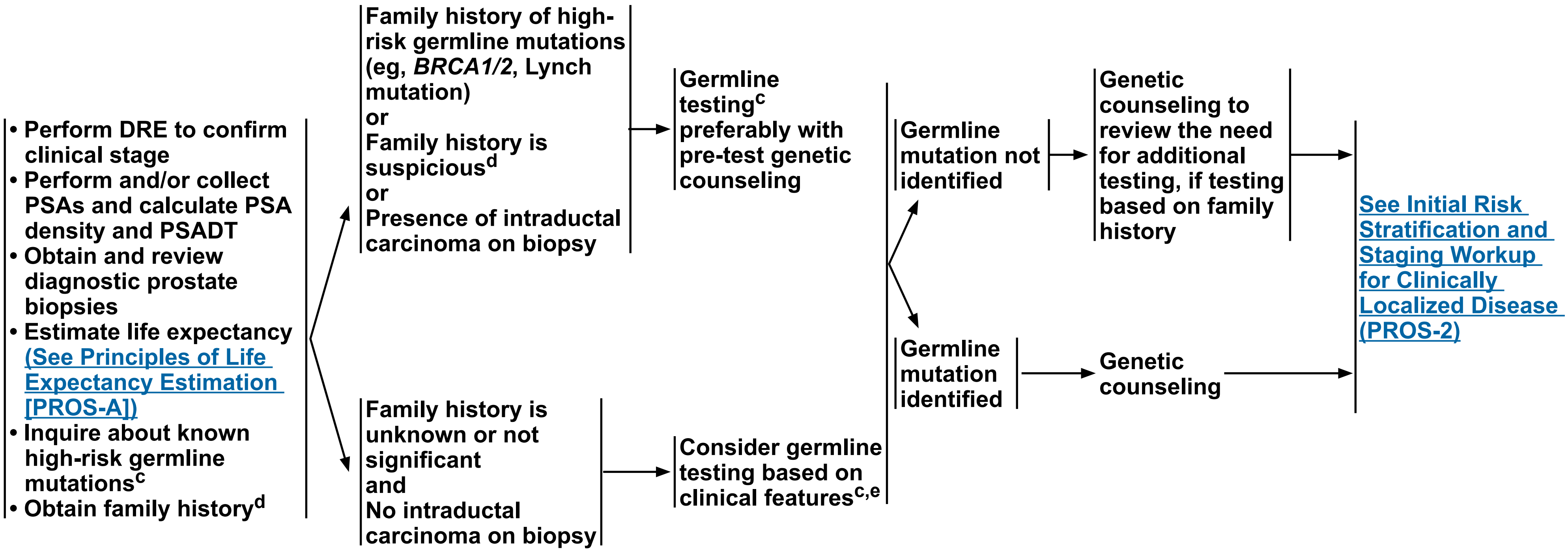
**Updates in Version 1.2019 of the NCCN Guidelines for Prostate Cancer from Version 4.2018 include:**

**PROS-F (1–5)**
- Principles of Androgen Deprivation Therapy, this section was extensively revised.
- Added a new bullet: Abiraterone with prednisone can be administered at a dose of 250 mg/day following a low-fat breakfast, as an alternative to the dose of 1000 mg/day after an overnight fast. The cost savings from this dosing may reduce financial toxicity and improve compliance. Szmulewitz RZ, Peer CJ, Ibraheem A, et al. Prospective international randomized phase II study of low-dose abiraterone with food versus standard dose abiraterone in castration-resistant prostate cancer. J Clin Oncol 2018;36:1389-1395.
- The LHRH antagonist degarelix was added as a new option for ADT for regional disease (category 2B), adjuvant treatment of lymph node metastases (category 2B), patients on observation who require treatment (category 2B), and as neoadjuvant/concurrent/adjuvant ADT as part of EBRT.

**PROS-G (1 of 2)**
- This section was reorganized.
- Combined and edited the two bullets about cabazitaxel: Cabazitaxel *at 25 mg/m²* with concurrent steroid has been shown in a randomized phase 3 study *(TROPIC)* to prolong overall survival, progression-free survival, and PSA and radiologic responses when compared with mitoxantrone and prednisone and is FDA approved in the post-docetaxel second-line setting. ~~Selection of patients without severe neuropathy and adequate liver, kidney, and bone marrow function is necessary, given the high risk of neutropenia and other side effects in this population, with consideration of prophylactic granulocyte growth factor injections.~~ *Toxicity at this dose was significant and included febrile neutropenia, severe diarrhea, fatigue, nausea/vomiting, anemia, thrombocytopenia, sepsis, and renal failure.* ~~Cabazitaxel at 20 mg/m² every 3 weeks with concurrent steroid is the standard of care in the post-docetaxel setting, with or without growth factor support.~~ A recent trial, PROSELICA, compared cabazitaxel 25 mg/m² every 3 weeks to 20 mg/m² every 3 weeks. Cabazitaxel 20 mg/m² had less toxicity; febrile neutropenia, diarrhea, and fatigue were less frequent. Cabazitaxel at 20 mg/m² had a significantly lower PSA response rate but nonsignificantly lower radiographic response rate and non-significantly shorter progression-free and overall survival (13.4 vs 14.5 mo) compared to 25 mg/m². Cabazitaxel starting dose can be either 20 mg/m² or 25 mg/m² for men with mCRPC who have progressed despite prior docetaxel chemotherapy. Cabazitaxel 25 mg/m² with concurrent steroid may be considered for healthy men who wish to be more aggressive. *Growth factor support may be needed with either dose.*

**PROS-G (2 of 2)**
- Immunotherapy
  - Added *Sipuleucel-T is not recommended for patients with small cell/neuroendocrine prostate cancer.*
- Removed bullet: Men with advanced prostate cancer should be encouraged to participate in clinical trials and referred early to a medical oncologist.
- Modified: *A phase 3* clinical trial *that assessed* ~~are in progress that assess~~ a role for zoledronic acid ~~or denosumab~~ in men beginning ADT for bone metastases *was negative*.
- Modified: Denosumab *(preferred)* is given subcutaneously every 4 weeks.
- Modified: Zoledronic acid is given intravenously every 3 to 4 weeks *or every 12 weeks.*

## INITIAL PROSTATE CANCER DIAGNOSIS[a,b]



- Perform DRE to confirm clinical stage
- Perform and/or collect PSAs and calculate PSA density and PSADT
- Obtain and review diagnostic prostate biopsies
- Estimate life expectancy (See Principles of Life Expectancy Estimation [PROS-A])
- Inquire about known high-risk germline mutations[c]
- Obtain family history[d]

Family history of high-risk germline mutations (eg, *BRCA1/2*, Lynch mutation)
or
Family history is suspicious[d]
or
Presence of intraductal carcinoma on biopsy
→ Germline testing[c] preferably with pre-test genetic counseling

Family history is unknown or not significant
and
No intraductal carcinoma on biopsy
→ Consider germline testing based on clinical features[c,e]

Germline mutation not identified → Genetic counseling to review the need for additional testing, if testing based on family history → See Initial Risk Stratification and Staging Workup for Clinically Localized Disease (PROS-2)

Germline mutation identified → Genetic counseling → See Initial Risk Stratification and Staging Workup for Clinically Localized Disease (PROS-2)

[a] See NCCN Guidelines for Older Adult Oncology for tools to aid optimal assessment and management of older adults.

[b] See NCCN Guidelines for Prostate Cancer Early Detection.

[c] Family history for known germline variants and genetic testing for germline variants should include *MLH1, MSH2, MSH6, and PMS2* (for Lynch syndrome) and homologous recombination genes *BRCA1, BRCA2, ATM, PALB2,* and *CHEK2.* Consider cancer predisposition next-generation sequencing (NGS) panel testing, which includes *BRCA2, BRCA1, ATM, CHEK2, PALB2, MLH1, MSH2, MSH6,* and *PMS2.* Additional genes may be appropriate depending on clinical context. For example, *HOXB13* is a prostate cancer risk gene that does not have clear therapeutic implications in advanced disease, but testing may be valuable for family counseling.

[d] Family history criteria and consideration to prompt genetic testing:
- A strong family history of prostate cancer consists of: brother or father or multiple family members who were diagnosed with prostate cancer (but not clinically localized Grade Group 1) at less than 60 years of age or who died from prostate cancer
- Ashkenazi Jewish ancestry
- ≥3 cancers on same side of family, especially diagnoses ≤50 years of age: bile duct, breast, colorectal, endometrial, gastric, kidney, melanoma, ovarian, pancreatic, prostate (but not clinically localized Grade Group 1), small bowel, or urothelial cancer

[e] Genetic testing in the absence of family history or clinical features (eg, high- or very-high-risk prostate cancer, intraductal histology) may be of low yield. The patient should be counseled to inform providers of any update to family history.

## INITIAL RISK STRATIFICATION AND STAGING WORKUP FOR CLINICALLY LOCALIZED DISEASE

| Risk group | Clinical/pathologic features | | | Imaging[h,i] | Germline testing | Molecular and biomarker analysis of tumor[l] | Initial therapy |
|---|---|---|---|---|---|---|---|
| Very low[f] | • T1c AND<br>• Grade Group 1 AND<br>• PSA <10 ng/mL AND<br>• Fewer than 3 prostate biopsy fragments/cores positive, ≤50% cancer in each fragment/core[g] AND<br>• PSA density <0.15 ng/mL/g | | | Not indicated | Recommended if family history positive or intraductal histology See PROS-1 | Not indicated | See PROS-4 |
| Low[f] | • T1-T2a AND<br>• Grade Group 1 AND<br>• PSA <10 ng/mL | | | Not indicated | Recommended if family history positive or intraductal histology See PROS-1 | Consider if life expectancy ≥10y[m] | See PROS-5 |
| Intermediate[f] | Has no high- or very-high-risk features and has one or more intermediate risk factors (IRF):<br>• T2b-T2c<br>• Grade Group 2 or 3<br>• PSA 10–20 ng/mL | Favorable intermediate | • 1 IRF and<br>• Grade Group 1 or 2 and<br>• <50% biopsy cores positive[g] | • Bone imaging[j]: not recommended for staging<br>• Pelvic ± abdominal imaging: recommended if nomogram predicts >10% probability of pelvic lymph node involvement<br>• If regional or distant metastases are found, see PROS-9 | Recommended if family history positive or intraductal histology See PROS-1 | Consider if life expectancy ≥10y[m] | See PROS-6 |
| | | Unfavorable intermediate | • 2 or 3 IRFs and/or<br>• Grade Group 3 and/or<br>• ≥50% biopsy cores positive[g] | • Bone imaging[j]: recommended if T2 and PSA >10 ng/mL<br>• Pelvic ± abdominal imaging: recommended if nomogram predicts >10% probability of pelvic lymph node involvement<br>• If regional or distant metastases are found, see PROS-9 | Recommended if family history positive or intraductal histology See PROS-1 | Not routinely recommended | See PROS-7 |
| High | • T3a OR<br>• Grade Group 4 or Grade Group 5 OR<br>• PSA >20 ng/mL | | | • Bone imaging[j]: recommended<br>• Pelvic ± abdominal imaging: recommended if nomogram predicts >10% probability of pelvic lymph node involvement<br>• If regional or distant metastases are found, see PROS-9 | Recommended[c,k] | Not routinely recommended | See PROS-8 |
| Very high | • T3b-T4 OR<br>• Primary Gleason pattern 5 OR<br>• >4 cores with Grade Group 4 or 5 | | | • Bone imaging[j]: recommended<br>• Pelvic ± abdominal imaging: recommended if nomogram predicts >10% probability of pelvic lymph node involvement<br>• If regional or distant metastases are found, see PROS-9 | Recommended[c,k] | Not routinely recommended | See PROS-8 |

**Note: All recommendations are category 2A unless otherwise indicated.**
**Clinical Trials: NCCN believes that the best management of any patient with cancer is in a clinical trial. Participation in clinical trials is especially encouraged.**

## INITIAL RISK STRATIFICATION AND STAGING WORKUP FOR CLINICALLY LOCALIZED DISEASE FOOTNOTES

[c] Family history for known germline variants and genetic testing for germline variants should include *MLH1, MSH2, MSH6, and PMS2* (for Lynch syndrome) and homologous recombination genes *BRCA1, BRCA2, ATM, PALB2,* and *CHEK2.* Consider cancer predisposition NGS panel testing, which includes *BRCA2, BRCA1, ATM, CHEK2, PALB2, MLH1, MSH2, MSH6,* and *PMS2.* Additional genes may be appropriate depending on clinical context. For example, *HOXB13* is a prostate cancer risk gene that does not have clear therapeutic implications in advanced disease, but testing may be valuable for family counseling.

[f] For asymptomatic patients in very-low-, low-, and intermediate-risk groups with life expectancy ≤5 years, no further workup or treatment is indicated until the patient becomes symptomatic.

[g] An ultrasound- or MRI- or DRE-targeted lesion that is biopsied more than once and demonstrates cancer (regardless of percentage core involvement or number of cores involved) counts as a single positive core.

[h] See Principles of Imaging (PROS-B).

[i] Bone imaging should be performed for any patient with symptoms consistent with bone metastases.

[j] Plain films, CT, MRI, F-18 sodium fluoride PET/CT or PET/MRI, C-11 choline PET/CT or PET/MRI, or F-18 fluciclovine PET/CT or PET/MRI can be considered for equivocal results on initial bone scan. See PROS-B.

[k] The prevalence of inherited (germline) DNA repair gene mutations in men with metastatic prostate cancer, unselected for family history (n = 692), was found to be 11.8% (*BRCA2* 5.3%, *ATM* 1.6%, *CHEK2* 1.9%, *BRCA*1 0.9%, *RAD51D* 0.4%, and *PALB2* 0.4%), and 6% in the localized high-risk population in the TCGA cohort (Cancer Genome Atlas Research Network. The molecular taxonomy of primary prostate cancer. Cell 2015;163:1011-25; Pritchard CC, Mateo J, Walsh MF, et al. Inherited DNA-repair gene mutations in men with metastatic prostate cancer. N Engl J Med 2016;375:443-453). Germline genetic testing is recommended for all men with high-risk, very-high-risk, regional, or metastatic prostate cancer. Genetic counseling resources and support is critical and pre-test counseling is preferred when feasible. Post-test genetic counseling is recommended if a mutation is identified.

[l] Patients should be informed that somatic tumor sequencing has the potential to uncover germline findings. However, virtually no NGS tests are designed or validated for germline assessment. Therefore, overinterpretation of germline findings should be avoided. If a germline mutation is suspected, the patient should be recommended for genetic counseling and follow-up dedicated germline testing.

[m] Men with low or favorable intermediate-risk disease may consider the use of the following tumor-based molecular assays: Decipher, Oncotype DX Prostate, Prolaris, and ProMark. Retrospective studies have shown that molecular assays performed on prostate biopsy or radical prostatectomy specimens provide prognostic information independent of NCCN or CAPRA risk groups. These include, but are not limited to, likelihood of death with conservative management, likelihood of biochemical progression after radical prostatectomy or external beam therapy, and likelihood of developing metastasis after radical prostatectomy or salvage radiotherapy. See Discussion.

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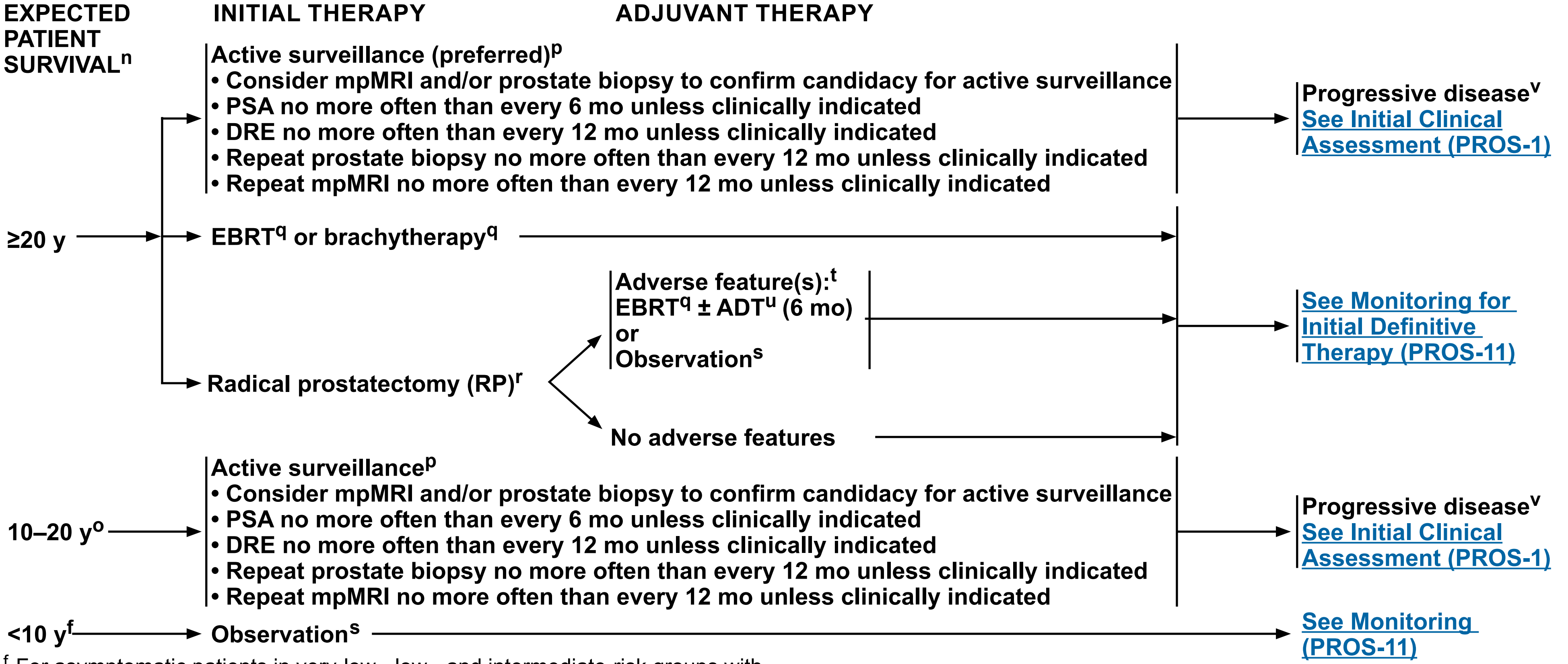
## VERY LOW RISK GROUP



**EXPECTED PATIENT SURVIVAL[n]** | **INITIAL THERAPY** | **ADJUVANT THERAPY**

**≥20 y** →

- **Active surveillance (preferred)[p]**
  - **Consider mpMRI and/or prostate biopsy to confirm candidacy for active surveillance**
  - **PSA no more often than every 6 mo unless clinically indicated**
  - **DRE no more often than every 12 mo unless clinically indicated**
  - **Repeat prostate biopsy no more often than every 12 mo unless clinically indicated**
  - **Repeat mpMRI no more often than every 12 mo unless clinically indicated**

  → **Progressive disease[v]** **See Initial Clinical Assessment (PROS-1)**
- **EBRT[q] or brachytherapy[q]** → **See Monitoring for Initial Definitive Therapy (PROS-11)**
- **Radical prostatectomy (RP)[r]**
  - **Adverse feature(s):[t] EBRT[q] ± ADT[u] (6 mo) or Observation[s]** → **See Monitoring for Initial Definitive Therapy (PROS-11)**
  - **No adverse features** → **See Monitoring for Initial Definitive Therapy (PROS-11)**

**10–20 y[o]** → **Active surveillance[p]**

- **Consider mpMRI and/or prostate biopsy to confirm candidacy for active surveillance**
- **PSA no more often than every 6 mo unless clinically indicated**
- **DRE no more often than every 12 mo unless clinically indicated**
- **Repeat prostate biopsy no more often than every 12 mo unless clinically indicated**
- **Repeat mpMRI no more often than every 12 mo unless clinically indicated**

→ **Progressive disease[v]** **See Initial Clinical Assessment (PROS-1)**

**<10 y[f]** → **Observation[s]** → **See Monitoring (PROS-11)**

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[f] For asymptomatic patients in very-low-, low-, and intermediate-risk groups with life expectancy ≤5 years, no further workup or treatment is indicated until the patient becomes symptomatic.

[n] See Principles of Life Expectancy Estimation (PROS-A).

[o] The panel remains concerned about the problems of overtreatment related to the increased diagnosis of early prostate cancer from PSA testing. See NCCN Guidelines for Prostate Cancer Early Detection. Active surveillance is recommended for this subset of patients.

[p] Active surveillance involves actively monitoring the course of disease with the expectation to intervene with potentially curative therapy if the cancer progresses. See Principles of Active Surveillance and Observation (PROS-C).

[q] Principles of Radiation Therapy (PROS-D).

[r] Principles of Surgery (PROS-E).

[s] Observation involves monitoring the course of disease with the expectation to deliver palliative therapy for the development of symptoms or a change in exam or PSA that suggests symptoms are imminent. Principles of Active Surveillance and Observation (PROS-C).

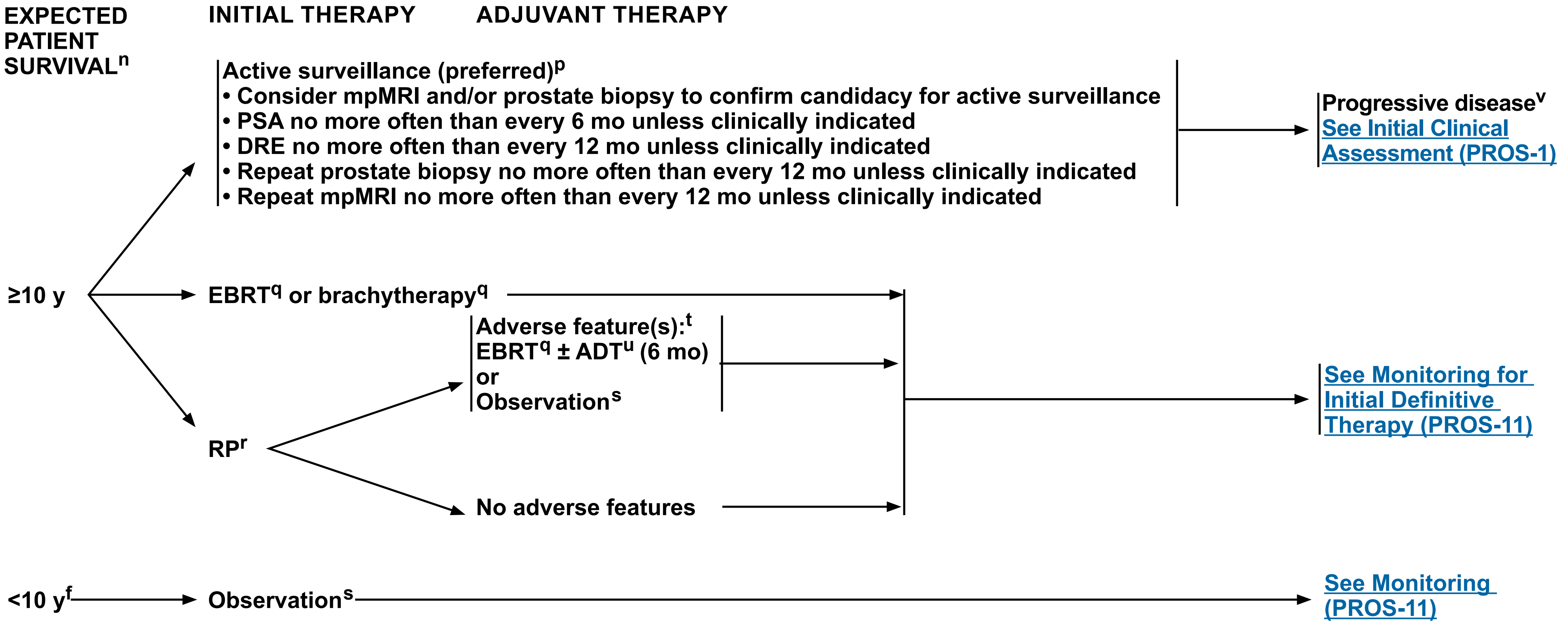
[t] Adverse laboratory/pathologic features include: positive margin(s); seminal vesicle invasion; extracapsular extension; or detectable PSA.

[u] Principles of Androgen Deprivation Therapy (PROS-F).

[v] Criteria for progression are not well defined and require physician judgment; however, a change in risk group strongly implies disease progression. See Discussion.

**Note: All recommendations are category 2A unless otherwise indicated.**
**Clinical Trials: NCCN believes that the best management of any patient with cancer is in a clinical trial. Participation in clinical trials is especially encouraged.**

## LOW RISK GROUP



**EXPECTED PATIENT SURVIVAL[n]**

**INITIAL THERAPY**

**ADJUVANT THERAPY**

**≥10 y**

**Active surveillance (preferred)[p]**
- **Consider mpMRI and/or prostate biopsy to confirm candidacy for active surveillance**
- **PSA no more often than every 6 mo unless clinically indicated**
- **DRE no more often than every 12 mo unless clinically indicated**
- **Repeat prostate biopsy no more often than every 12 mo unless clinically indicated**
- **Repeat mpMRI no more often than every 12 mo unless clinically indicated**

**Progressive disease[v]**
**See Initial Clinical Assessment (PROS-1)**

**EBRT[q] or brachytherapy[q]**

**RP[r]**

**Adverse feature(s):[t]**
**EBRT[q] ± ADT[u] (6 mo)**
**or**
**Observation[s]**

**No adverse features**

**See Monitoring for Initial Definitive Therapy (PROS-11)**

**<10 y[f]**

**Observation[s]**

**See Monitoring (PROS-11)**

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[f] For asymptomatic patients in very-low-, low-, and intermediate-risk groups with life expectancy ≤5 years, no further workup or treatment is indicated until the patient becomes symptomatic.

[n] See Principles of Life Expectancy Estimation (PROS-A).

[q] Principles of Radiation Therapy (PROS-D).

[p] Active surveillance involves actively monitoring the course of disease with the expectation to intervene with potentially curative therapy if the cancer progresses. Principles of Active Surveillance and Observation (PROS-C).

[r] Principles of Surgery (PROS-E).

[s] Observation involves monitoring the course of disease with the expectation to deliver palliative therapy for the development of symptoms or a change in exam or PSA that suggests symptoms are imminent. Principles of Active Surveillance and Observation (PROS-C).

[t] Adverse laboratory/pathologic features include: positive margin(s); seminal vesicle invasion; extracapsular extension; or detectable PSA.

[u] Principles of Androgen Deprivation Therapy (PROS-F).

[v] Criteria for progression are not well defined and require physician judgment; however, a change in risk group strongly implies disease progression. See Discussion.

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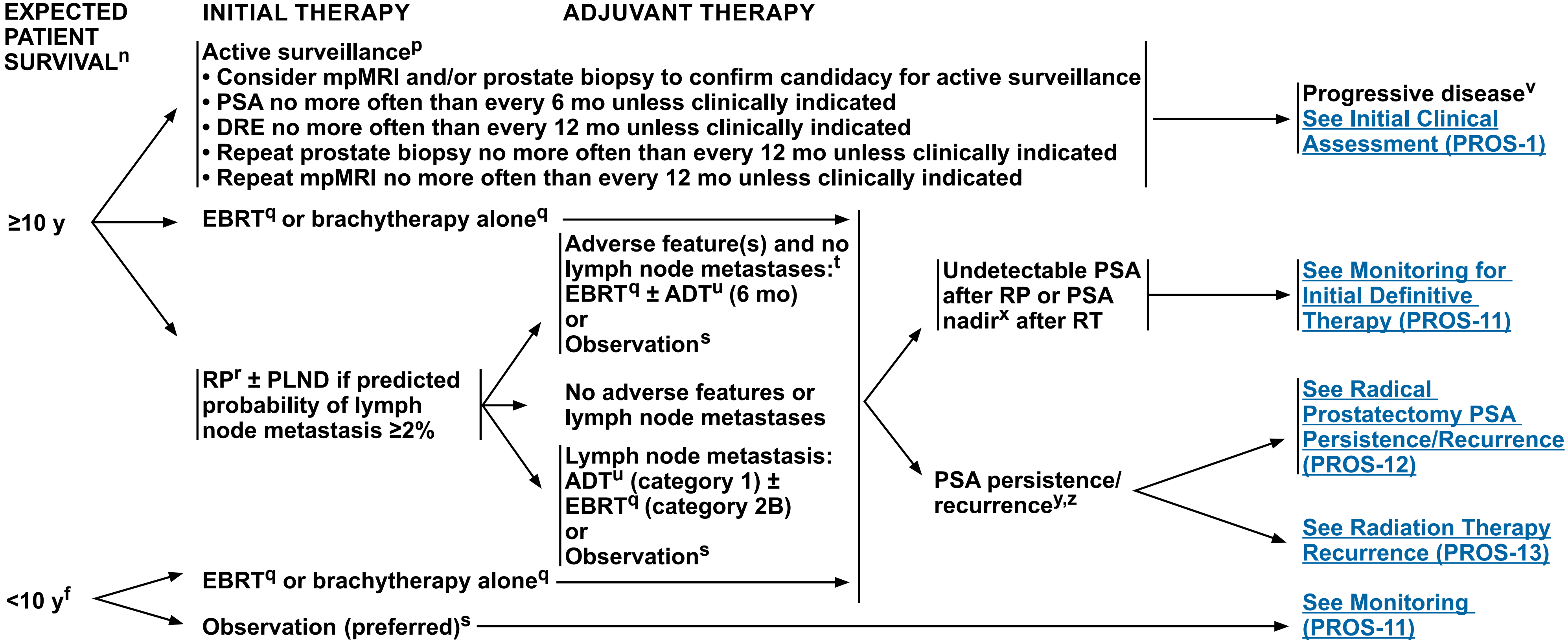
## FAVORABLE INTERMEDIATE RISK GROUP



**EXPECTED PATIENT SURVIVAL[n]**

**INITIAL THERAPY**

**ADJUVANT THERAPY**

**≥10 y**

**Active surveillance[p]**
- **Consider mpMRI and/or prostate biopsy to confirm candidacy for active surveillance**
- **PSA no more often than every 6 mo unless clinically indicated**
- **DRE no more often than every 12 mo unless clinically indicated**
- **Repeat prostate biopsy no more often than every 12 mo unless clinically indicated**
- **Repeat mpMRI no more often than every 12 mo unless clinically indicated**

→ **Progressive disease[v]** See Initial Clinical Assessment (PROS-1)

**EBRT[q] or brachytherapy alone[q]**

**RP[r] ± PLND if predicted probability of lymph node metastasis ≥2%**

- **Adverse feature(s) and no lymph node metastases:[t] EBRT[q] ± ADT[u] (6 mo) or Observation[s]**
- **No adverse features or lymph node metastases**
- **Lymph node metastasis: ADT[u] (category 1) ± EBRT[q] (category 2B) or Observation[s]**

**Undetectable PSA after RP or PSA nadir[x] after RT** → See Monitoring for Initial Definitive Therapy (PROS-11)

**PSA persistence/ recurrence[y,z]** → See Radical Prostatectomy PSA Persistence/Recurrence (PROS-12); See Radiation Therapy Recurrence (PROS-13)

**<10 y[f]**

**EBRT[q] or brachytherapy alone[q]**

**Observation (preferred)[s]** → See Monitoring (PROS-11)

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[f] For asymptomatic patients in very-low-, low-, and intermediate-risk groups with life expectancy ≤5 years, no further workup or treatment is indicated until the patient becomes symptomatic.

[n] See Principles of Life Expectancy Estimation (PROS-A).

[p] Active surveillance involves actively monitoring the course of disease with the expectation to intervene with potentially curative therapy if the cancer progresses. See Principles of Active Surveillance and Observation (PROS-C).

[q] See Principles of Radiation Therapy (PROS-D).

[r] See Principles of Surgery (PROS-E).

[s] Observation involves monitoring the course of disease with the expectation to deliver palliative therapy for the development of symptoms or a change in exam or PSA that suggests symptoms are imminent. See Principles of Active Surveillance and Observation (PROS-C).

[t] Adverse laboratory/pathologic features include: positive margin(s); seminal vesicle invasion; extracapsular extension; or detectable PSA.

[u] See Principles of Androgen Deprivation Therapy (PROS-F).

[v] Criteria for progression are not well defined and require physician judgment; however, a change in risk group strongly implies disease progression. See Discussion.

[x] PSA nadir is the lowest value reached after RT.

[y] PSA persistence/recurrence after RP is defined as failure of PSA to fall to undetectable levels (PSA persistence) or undetectable PSA after RP with a subsequent detectable PSA that increases on 2 or more determinations (PSA recurrence).

[z] RTOG-ASTRO (Radiation Therapy Oncology Group - American Society for Therapeutic Radiology and Oncology) Phoenix Consensus: 1) PSA increase by 2 ng/mL or more above the nadir PSA is the standard definition for PSA persistence/recurrence after EBRT with or without HT; and 2) A recurrence evaluation should be considered when PSA has been confirmed to be increasing after radiation even if the increase above nadir is not yet 2 ng/mL, especially in candidates for salvage local therapy who are young and healthy. Retaining a strict version of the ASTRO definition allows comparison with a large existing body of literature. Rapid increase of PSA may warrant evaluation (prostate biopsy) prior to meeting the Phoenix definition, especially in younger or healthier men.

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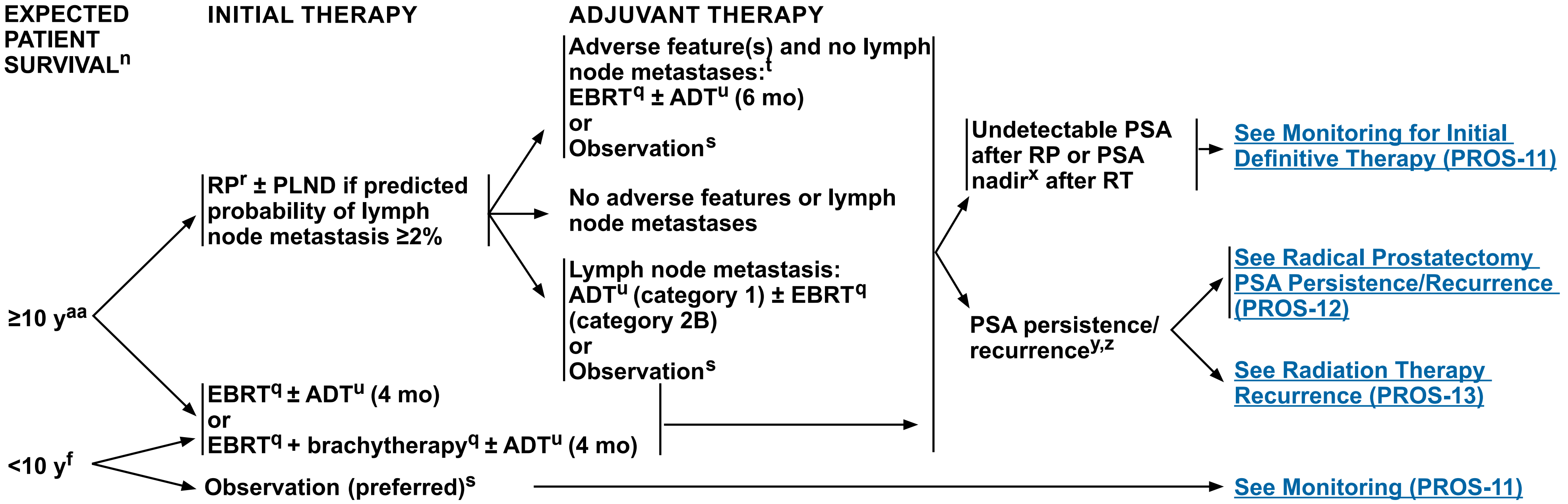
## UNFAVORABLE INTERMEDIATE RISK GROUP



**EXPECTED PATIENT SURVIVAL[n]** | **INITIAL THERAPY** | **ADJUVANT THERAPY**

**≥10 y[aa]**

- **RP[r] ± PLND if predicted probability of lymph node metastasis ≥2%**
  - **Adverse feature(s) and no lymph node metastases:[t] EBRT[q] ± ADT[u] (6 mo) or Observation[s]**
  - **No adverse features or lymph node metastases**
  - **Lymph node metastasis: ADT[u] (category 1) ± EBRT[q] (category 2B) or Observation[s]**
- **EBRT[q] ± ADT[u] (4 mo) or EBRT[q] + brachytherapy[q] ± ADT[u] (4 mo)**

**<10 y[f]**

- **EBRT[q] ± ADT[u] (4 mo) or EBRT[q] + brachytherapy[q] ± ADT[u] (4 mo)**
- **Observation (preferred)[s]** → **See Monitoring (PROS-11)**

After adjuvant therapy or EBRT:

- **Undetectable PSA after RP or PSA nadir[x] after RT** → **See Monitoring for Initial Definitive Therapy (PROS-11)**
- **PSA persistence/ recurrence[y,z]**
  - **See Radical Prostatectomy PSA Persistence/Recurrence (PROS-12)**
  - **See Radiation Therapy Recurrence (PROS-13)**

[f] For asymptomatic patients in very-low-, low-, and intermediate-risk groups with life expectancy ≤5 years, no further workup or treatment is indicated until the patient becomes symptomatic.

[n] See Principles of Life Expectancy Estimation (PROS-A).

[q] See Principles of Radiation Therapy (PROS-D).

[r] See Principles of Surgery (PROS-E).

[s] Observation involves monitoring the course of disease with the expectation to deliver palliative therapy for the development of symptoms or a change in exam or PSA that suggests symptoms are imminent. See Principles of Active Surveillance and Observation (PROS-C).

[t] Adverse laboratory/pathologic features include: positive margin(s); seminal vesicle invasion; extracapsular extension; or detectable PSA.

[u] See Principles of Androgen Deprivation Therapy (PROS-F).

[x] PSA nadir is the lowest value reached after RT.

[y] PSA persistence/recurrence after RP is defined as failure of PSA to fall to undetectable levels (PSA persistence) or undetectable PSA after RP with a subsequent detectable PSA that increases on 2 or more determinations (PSA recurrence).

[z] RTOG-ASTRO (Radiation Therapy Oncology Group - American Society for Therapeutic Radiology and Oncology) Phoenix Consensus: 1) PSA increase by 2 ng/mL or more above the nadir PSA is the standard definition for PSA persistence/ recurrence after EBRT with or without HT; and 2) A recurrence evaluation should be considered when PSA has been confirmed to be increasing after radiation even if the increase above nadir is not yet 2 ng/mL, especially in candidates for salvage local therapy who are young and healthy. Retaining a strict version of the ASTRO definition allows comparison with a large existing body of literature. Rapid increase of PSA may warrant evaluation (prostate biopsy) prior to meeting the Phoenix definition, especially in younger or healthier men.

[aa] Active surveillance of unfavorable intermediate and high-risk clinically localized cancers is not recommended in patients with a life expectancy >10 years (category 1).

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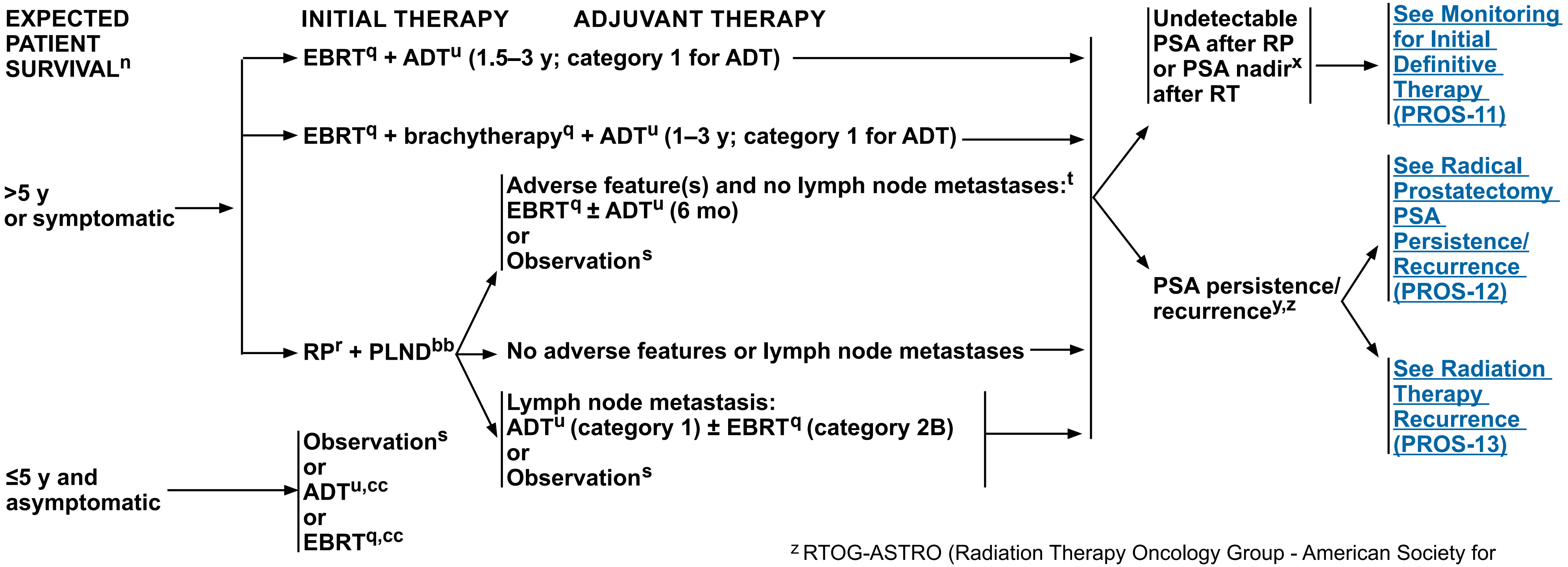
## HIGH OR VERY HIGH RISK GROUP



**EXPECTED PATIENT SURVIVAL[n]**

**INITIAL THERAPY**

**ADJUVANT THERAPY**

**>5 y or symptomatic**
- **EBRT[q] + ADT[u] (1.5–3 y; category 1 for ADT)**
- **EBRT[q] + brachytherapy[q] + ADT[u] (1–3 y; category 1 for ADT)**
- **RP[r] + PLND[bb]**
  - **Adverse feature(s) and no lymph node metastases:[t] EBRT[q] ± ADT[u] (6 mo) or Observation[s]**
  - **No adverse features or lymph node metastases**
  - **Lymph node metastasis: ADT[u] (category 1) ± EBRT[q] (category 2B) or Observation[s]**

**Undetectable PSA after RP or PSA nadir[x] after RT** → See Monitoring for Initial Definitive Therapy (PROS-11)

**PSA persistence/ recurrence[y,z]**
- See Radical Prostatectomy PSA Persistence/ Recurrence (PROS-12)
- See Radiation Therapy Recurrence (PROS-13)

**≤5 y and asymptomatic** → **Observation[s] or ADT[u,cc] or EBRT[q,cc]**

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[n] See Principles of Life Expectancy Estimation (PROS-A).

[q] See Principles of Radiation Therapy (PROS-D).

[r] See Principles of Surgery (PROS-E).

[s] Observation involves monitoring the course of disease with the expectation to deliver palliative therapy for the development of symptoms or a change in exam or PSA that suggests symptoms are imminent. See Principles of Active Surveillance and Observation (PROS-C).

[t] Adverse laboratory/pathologic features include: positive margin(s); seminal vesicle invasion; extracapsular extension; or detectable PSA.

[u] See Principles of Androgen Deprivation Therapy (PROS-F).

[x] PSA nadir is the lowest value reached after RT.

[y] PSA persistence/recurrence after RP is defined as failure of PSA to fall to undetectable levels (PSA persistence) or undetectable PSA after RP with a subsequent detectable PSA that increases on 2 or more determinations (PSA recurrence).

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[bb] RP + PLND can be considered in younger, healthier patients without tumor fixation to the pelvic side-wall.

[cc] Androgen deprivation therapy (ADT) or radiation therapy (RT) may be considered in selected patients with high- or very-high-risk disease, where complications, such as hydronephrosis or metastasis, can be expected within 5 y.

**Note: All recommendations are category 2A unless otherwise indicated.**
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## GENETIC AND MOLECULAR BIOMARKER ANALYSIS FOR ADVANCED PROSTATE CANCER

| Risk group | Clinical/pathologic features | Germline testing | Molecular and biomarker analysis of tumor[l] | Initial therapy |
|---|---|---|---|---|
| **Regional** | **Any T, N1, M0** | **Recommended[c,k]** | **Consider tumor testing for homologous recombination gene mutations and for microsatellite instability (MSI) or mismatch repair deficiency (dMMR)[dd,ee]** | **See PROS-10** |
| **Metastatic[ff]** | **Any T, Any N, M1** | **Recommended[c,k]** | **Consider tumor testing for homologous recombination gene mutations and for MSI or dMMR [dd,ee]** | **See PROS-14** |

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[c] Family history for known germline variants and genetic testing for germline variants should include *MLH1, MSH2, MSH6, and PMS2* (for Lynch syndrome) and homologous recombination genes *BRCA1, BRCA2, ATM, PALB2,* and *CHEK2.* Consider cancer predisposition NGS panel testing, which includes *BRCA2, BRCA1, ATM, CHEK2, PALB2, MLH1, MSH2, MSH6,* and *PMS2.* Additional genes may be appropriate depending on clinical context. For example, *HOXB13* is a prostate cancer risk gene that does not have clear therapeutic implications in advanced disease, but testing may be valuable for family counseling.

[k] The prevalence of inherited (germline) DNA repair gene mutations in men with metastatic prostate cancer, unselected for family history (n = 692), was found to be 11.8% (*BRCA2* 5.3%, *ATM* 1.6%, C*HEK2* 1.9%, *BRCA1* 0.9%, *RAD51D* 0.4%, and *PALB2* 0.4%, and 6% in the localized high-risk population in the TCGA cohort (Cancer Genome Atlas Research Network. The molecular taxonomy of primary prostate cancer. Cell 2015;163:1011-25; Pritchard CC, Mateo J, Walsh MF, et al. Inherited DNA-repair gene mutations in men with metastatic prostate cancer. N Engl J Med 2016;375:443-453). Germline genetic testing is recommended for all men with high-risk, very-high-risk, regional, or metastatic prostate cancer. Genetic counseling resources and support is critical and pre-test counseling is preferred when feasible. Post-test genetic counseling is recommended if a mutation is identified.

[l] Patients should be informed that somatic tumor sequencing has the potential to uncover germline findings. However, virtually no somatic NGS tests are designed or validated for germline assessment. Therefore, overinterpretation of germline findings should be avoided. If a germline mutation is suspected, the patient should be recommended for genetic counseling and follow-up dedicated germline testing.

[dd] DNA analysis for MSI and IHC for MMR are different assays measuring the same biological effect. If MSI is used, testing using an NGS assay validated for prostate cancer is preferred. If MSI-H or dMMR is found, refer to genetic counseling to assess for the possibility of Lynch syndrome. MSI-H or dMMR indicate eligibility for pembrolizumab in later lines of treatment for castration-resistant prostate cancer (CRPC) (see PROS-17 and PROS-18). Hempelmann JA, Lockwood CM, Konnick EQ, et al. Microsatellite instability in prostate cancer by PCR or NGS. J Immunother Cancer 2018;6:29.

[ee] Consider evaluating tumor for alterations in homologous recombination DNA repair such as: *BRCA1, BRCA2, ATM, PALB2, FANCA, RAD51D*, and *CHEK2*. At present, this information may be used for genetic counseling, early use of platinum chemotherapy, and/or eligibility for clinical trials (eg, PARP inhibitors). Clinical trials may include additional candidate DNA repair genes under investigation as molecular biomarkers. If mutations in *BRCA2, BRCA1, ATM, CHEK2*, or *PALB2* are found and/or there is a strong family history of cancer, refer to genetic counseling to assess for the possibility of hereditary breast and ovarian cancer (HBOC).

[ff] ADT alone (see PROS-F) or observation is recommended for asymptomatic patients with metastatic disease and life expectancy ≤5 years.

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## REGIONAL RISK GROUP

**EXPECTED PATIENT SURVIVAL[n]** → **INITIAL THERAPY**

**>5 y or symptomatic** →
- **EBRT[q] + ADT[u] (preferred)** → See Monitoring (PROS-11)
- **EBRT[q] + ADT[u] + abiraterone[f] and prednisone** → See Monitoring (PROS-11)
- **EBRT[q] + ADT[u] + abiraterone[u] and methylprednisolone (category 2B)** → See Monitoring (PROS-11)
- **ADT[u] ± abiraterone[u] and prednisone** → See Monitoring (PROS-11)
- **ADT[u] + abiraterone[u] and methylprednisolone (category 2B)** → See Monitoring (PROS-11)

**≤5 y and asymptomatic** →
**Observation[s]**
**or**
**ADT[u]**

---

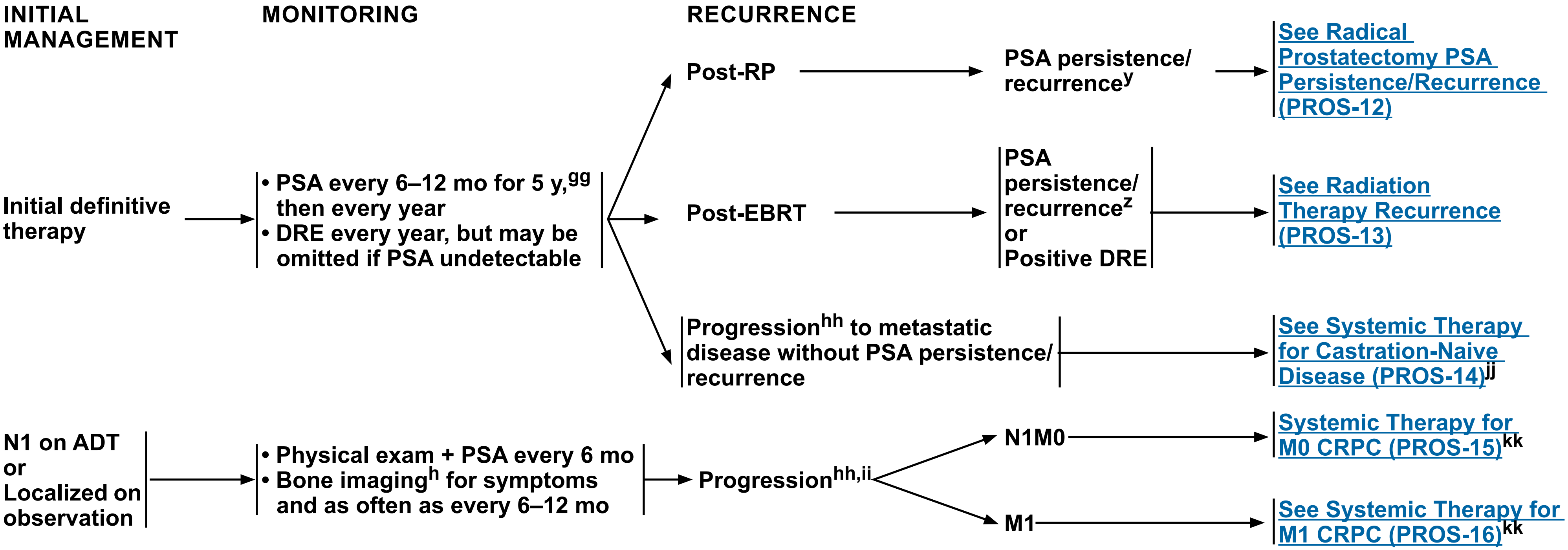
[n] See Principles of Life Expectancy Estimation (PROS-A).

[q] See Principles of Radiation Therapy (PROS-D).

[s] Observation involves monitoring the course of disease with the expectation to deliver palliative therapy for the development of symptoms or a change in exam or PSA that suggests symptoms are imminent. See Principles of Active Surveillance and Observation (PROS-C).

[u] See Principles of Androgen Deprivation Therapy (PROS-F).

**Note: All recommendations are category 2A unless otherwise indicated.**
**Clinical Trials: NCCN believes that the best management of any patient with cancer is in a clinical trial. Participation in clinical trials is especially encouraged.**



**INITIAL MANAGEMENT**

**MONITORING**

**RECURRENCE**

**Initial definitive therapy** → 
- **PSA every 6–12 mo for 5 y,[gg] then every year**
- **DRE every year, but may be omitted if PSA undetectable**

→ **Post-RP** → **PSA persistence/ recurrence[y]** → See Radical Prostatectomy PSA Persistence/Recurrence (PROS-12)

→ **Post-EBRT** → **PSA persistence/ recurrence[z] or Positive DRE** → See Radiation Therapy Recurrence (PROS-13)

→ **Progression[hh] to metastatic disease without PSA persistence/ recurrence** → See Systemic Therapy for Castration-Naive Disease (PROS-14)[jj]

**N1 on ADT or Localized on observation** → 
- **Physical exam + PSA every 6 mo**
- **Bone imaging[h] for symptoms and as often as every 6–12 mo**

→ **Progression[hh,ii]**
- → **N1M0** → Systemic Therapy for M0 CRPC (PROS-15)[kk]
- → **M1** → See Systemic Therapy for M1 CRPC (PROS-16)[kk]

[h] See Principles of Imaging (PROS-B).

[y] PSA persistence/recurrence after RP is defined as failure of PSA to fall to undetectable levels (PSA persistence) or undetectable PSA after RP with a subsequent detectable PSA that increases on 2 or more determinations (PSA recurrence).

[z] RTOG-ASTRO (Radiation Therapy Oncology Group - American Society for Therapeutic Radiology and Oncology) Phoenix Consensus: 1) PSA increase by 2 ng/mL or more above the nadir PSA is the standard definition for PSA persistence/recurrence after EBRT with or without HT; and 2) A recurrence evaluation should be considered when PSA has been confirmed to be increasing after radiation even if the increase above nadir is not yet 2 ng/mL, especially in candidates for salvage local therapy who are young and healthy. Retaining a strict version of the ASTRO definition allows comparison with a large existing body of literature. Rapid increase of PSA may warrant evaluation (prostate biopsy) prior to meeting the Phoenix definition, especially in younger or healthier men.

[gg] PSA as frequently as every 3 mo may be necessary to clarify disease status, especially in high-risk men.

[hh] Workup for progression should include bone imaging, chest CT, and abdominal/pelvic CT or abdominal/pelvic MRI with and without contrast. Consider C-11 choline PET/CT or PET/MRI or F-18 fluciclovine PET/CT or PET/MRI for further soft tissue and bone evaluation or F-18 sodium fluoride PET/CT or PET/MRI for further bone evaluation. The Panel remains unsure what to do when M1 is suggested by modern imaging but not on conventional imaging. See Principles of Imaging (PROS-B) and Discussion.

[ii] Treatment for patients who progressed on observation of localized disease is ADT (See Principles of Androgen Deprivation Therapy (PROS-F).

[jj] The term "castration-naive" is used to define patients who are not on ADT at the time of progression. The NCCN Prostate Cancer Panel uses the term "castration-naive" even when patients have had neoadjuvant, concurrent, or adjuvant ADT as part of radiation therapy provided they have recovered testicular function.

[kk] Castration-resistant prostate cancer (CRPC) is prostate cancer that progresses clinically, radiographically, or biochemically despite castrate levels of serum testosterone (<50 ng/dL). Scher HI, Halabi S, Tannock I, et al. Design and end points of clinical trials for patients with progressive prostate cancer and castrate levels of testosterone: recommendations of the Prostate Cancer Clinical Trials Working Group. J Clin Oncol 2008;26:1148-1159.

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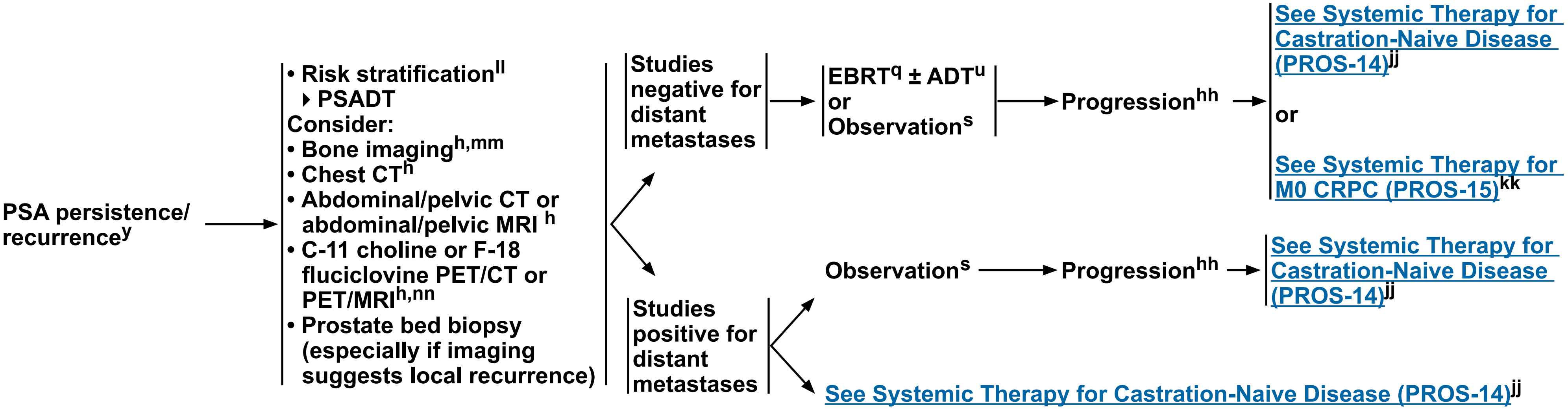
## RADICAL PROSTATECTOMY PSA PERSISTENCE/RECURRENCE



**PSA persistence/ recurrence[y]** →

- **Risk stratification[ll]**
  - **PSADT**

**Consider:**

- **Bone imaging[h,mm]**
- **Chest CT[h]**
- **Abdominal/pelvic CT or abdominal/pelvic MRI [h]**
- **C-11 choline or F-18 fluciclovine PET/CT or PET/MRI[h,nn]**
- **Prostate bed biopsy (especially if imaging suggests local recurrence)**

**Studies negative for distant metastases** → **EBRT[q] ± ADT[u] or Observation[s]** → **Progression[hh]** → **See Systemic Therapy for Castration-Naive Disease (PROS-14)[jj]** **or** **See Systemic Therapy for M0 CRPC (PROS-15)[kk]**

**Studies positive for distant metastases** → **Observation[s]** → **Progression[hh]** → **See Systemic Therapy for Castration-Naive Disease (PROS-14)[jj]**

**Studies positive for distant metastases** → **See Systemic Therapy for Castration-Naive Disease (PROS-14)[jj]**

---

[h] See Principles of Imaging (PROS-B).

[q] See Principles of Radiation Therapy (PROS-D).

[s] Observation involves monitoring the course of disease with the expectation to deliver palliative therapy for the development of symptoms or a change in exam or PSA that suggests symptoms are imminent. See Principles of Active Surveillance and Observation (PROS-C).

[u] See Principles of Androgen Deprivation Therapy (PROS-F).

[y] PSA persistence/recurrence after RP is defined as failure of PSA to fall to undetectable levels (PSA persistence) or undetectable PSA after RP with a subsequent detectable PSA that increases on 2 or more determinations (PSA recurrence).

[hh] Workup for progression should include bone imaging, chest CT, and abdominal/ pelvic CT or abdominal/pelvic MRI with and without contrast. Consider C-11 choline PET/CT or PET/MRI or F-18 fluciclovine PET/CT or PET/MRI for further soft tissue and bone evaluation or F-18 sodium fluoride PET/CT or PET/MRI for further bone evaluation. The Panel remains unsure what to do when M1 is suggested by modern imaging but not on conventional imaging. See Principles of Imaging (PROS-B) and Discussion.

[jj] The term "castration-naive" is used to define patients who are not on ADT at the time of progression. The NCCN Prostate Cancer Panel uses the term "castration-naive" even when patients have had neoadjuvant, concurrent, or adjuvant ADT as part of radiation therapy provided they have recovered testicular function.

[kk] Castration-resistant prostate cancer (CRPC) is prostate cancer that progresses clinically, radiographically, or biochemically despite castrate levels of serum testosterone (<50 ng/dL). Scher HI, Halabi S, Tannock I, et al. Design and end points of clinical trials for patients with progressive prostate cancer and castrate levels of testosterone: recommendations of the Prostate Cancer Clinical Trials Working Group. J Clin Oncol 2008;26:1148-1159.

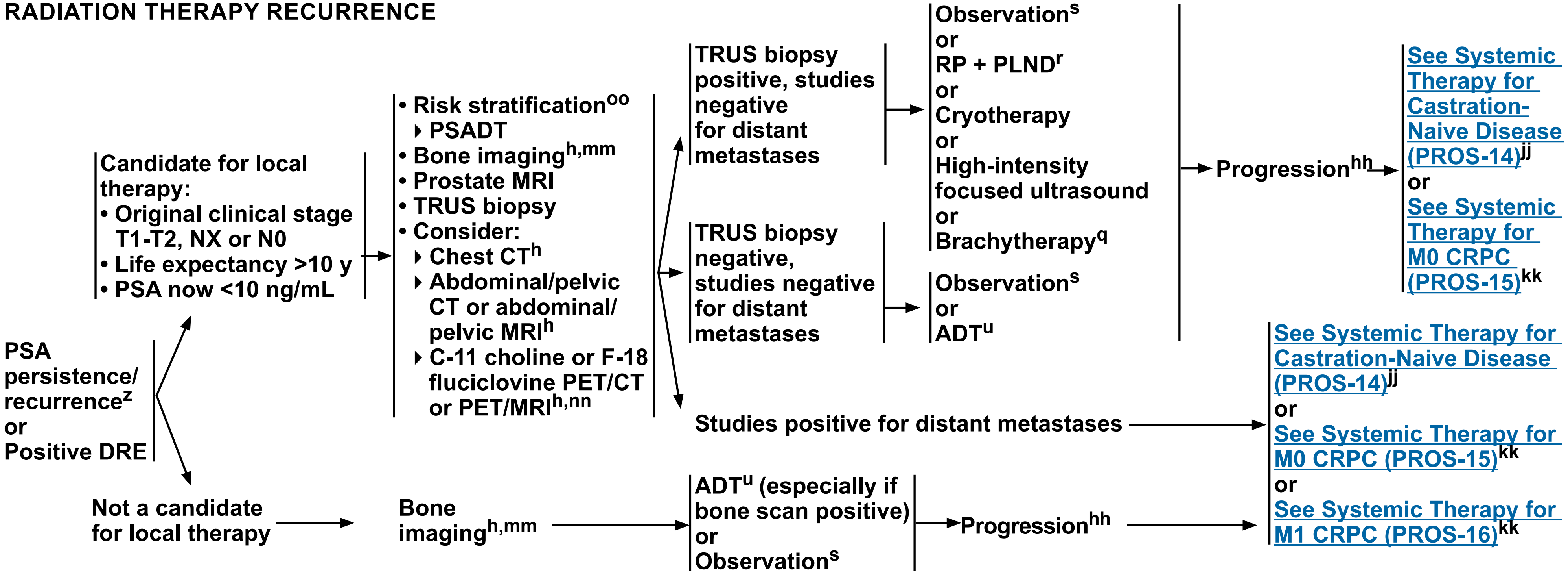
[ll] PSADT can be calculated to inform nomogram use and counseling and/or Decipher molecular assay (category 2B) can be considered to inform counseling.

[mm] F-18 sodium fluoride or C-11 choline or F-18 fluciclovine PET/CT or PET/MRI can be considered after bone scan for further evaluation when clinical suspicion of bone metastases is high.

[nn] Histologic confirmation is recommended whenever feasible due to significant rates of false positivity.

**Note: All recommendations are category 2A unless otherwise indicated.**
**Clinical Trials: NCCN believes that the best management of any patient with cancer is in a clinical trial. Participation in clinical trials is especially encouraged.**

## RADIATION THERAPY RECURRENCE



**PSA persistence/ recurrence[z] or Positive DRE**

**Candidate for local therapy:**
- **Original clinical stage T1-T2, NX or N0**
- **Life expectancy >10 y**
- **PSA now <10 ng/mL**

- **Risk stratification[oo]**
  - **PSADT**
- **Bone imaging[h,mm]**
- **Prostate MRI**
- **TRUS biopsy**
- **Consider:**
  - **Chest CT[h]**
  - **Abdominal/pelvic CT or abdominal/ pelvic MRI[h]**
  - **C-11 choline or F-18 fluciclovine PET/CT or PET/MRI[h,nn]**

**TRUS biopsy positive, studies negative for distant metastases** → **Observation[s] or RP + PLND[r] or Cryotherapy or High-intensity focused ultrasound or Brachytherapy[q]**

**TRUS biopsy negative, studies negative for distant metastases** → **Observation[s] or ADT[u]**

→ **Progression[hh]** → **See Systemic Therapy for Castration-Naive Disease (PROS-14)[jj] or See Systemic Therapy for M0 CRPC (PROS-15)[kk]**

**Studies positive for distant metastases** → **See Systemic Therapy for Castration-Naive Disease (PROS-14)[jj] or See Systemic Therapy for M0 CRPC (PROS-15)[kk] or See Systemic Therapy for M1 CRPC (PROS-16)[kk]**

**Not a candidate for local therapy** → **Bone imaging[h,mm]** → **ADT[u] (especially if bone scan positive) or Observation[s]** → **Progression[hh]** → **See Systemic Therapy for M1 CRPC (PROS-16)[kk]**

---

[h] See Principles of Imaging (PROS-B).

[q] See Principles of Radiation Therapy (PROS-D).

[r] See Principles of Surgery (PROS-E).

[s] Observation involves monitoring the course of disease with the expectation to deliver palliative therapy for the development of symptoms or a change in exam or PSA that suggests symptoms are imminent. See Principles of Active Surveillance and Observation (PROS-C).

[u] See Principles of Androgen Deprivation Therapy (PROS-F).

[z] RTOG-ASTRO (Radiation Therapy Oncology Group - American Society for Therapeutic Radiology and Oncology) Phoenix Consensus: 1) PSA increase by 2 ng/mL or more above the nadir PSA is the standard definition for PSA persistence/recurrence after EBRT with or without HT; and 2) A recurrence evaluation should be considered when PSA has been confirmed to be increasing after radiation even if the increase above nadir is not yet 2 ng/mL, especially in candidates for salvage local therapy who are young and healthy. Retaining a strict version of the ASTRO definition allows comparison with a large existing body of literature. Rapid increase of PSA may warrant evaluation (prostate biopsy) prior to meeting the Phoenix definition, especially in younger or healthier men.

[hh] Workup for progression should include bone imaging, chest CT, and abdominal/pelvic CT or abdominal/pelvic MRI with and without contrast. Consider C-11 choline PET/CT or PET/MRI or F-18 fluciclovine PET/CT or PET/MRI for further soft tissue and bone evaluation or F-18 sodium fluoride PET/CT or PET/MRI for further bone evaluation. The Panel remains unsure what to do when M1 is suggested by modern imaging but not on conventional imaging. See Principles of Imaging (PROS-B) and Discussion.

[jj] The term "castration-naive" is used to define patients who are not on ADT at the time of progression. The NCCN Prostate Cancer Panel uses the term "castration-naive" even when patients have had neoadjuvant, concurrent, or adjuvant ADT as part of radiation therapy provided they have recovered testicular function.

[kk] Castration-resistant prostate cancer (CRPC) is prostate cancer that progresses clinically, radiographically, or biochemically despite castrate levels of serum testosterone (<50 ng/dL). Scher HI, Halabi S, Tannock I, et al. Design and end points of clinical trials for patients with progressive prostate cancer and castrate levels of testosterone: recommendations of the Prostate Cancer Clinical Trials Working Group. J Clin Oncol 2008;26:1148-1159.

[mm] F-18 sodium fluoride or C-11 choline or F-18 fluciclovine PET/CT or PET/MRI can be considered after bone scan for further evaluation when clinical suspicion of bone metastases is high.

[nn] Histologic confirmation is recommended whenever feasible due to significant rates of false positivity.

[oo] PSADT can be calculated to inform nomogram use and counseling.

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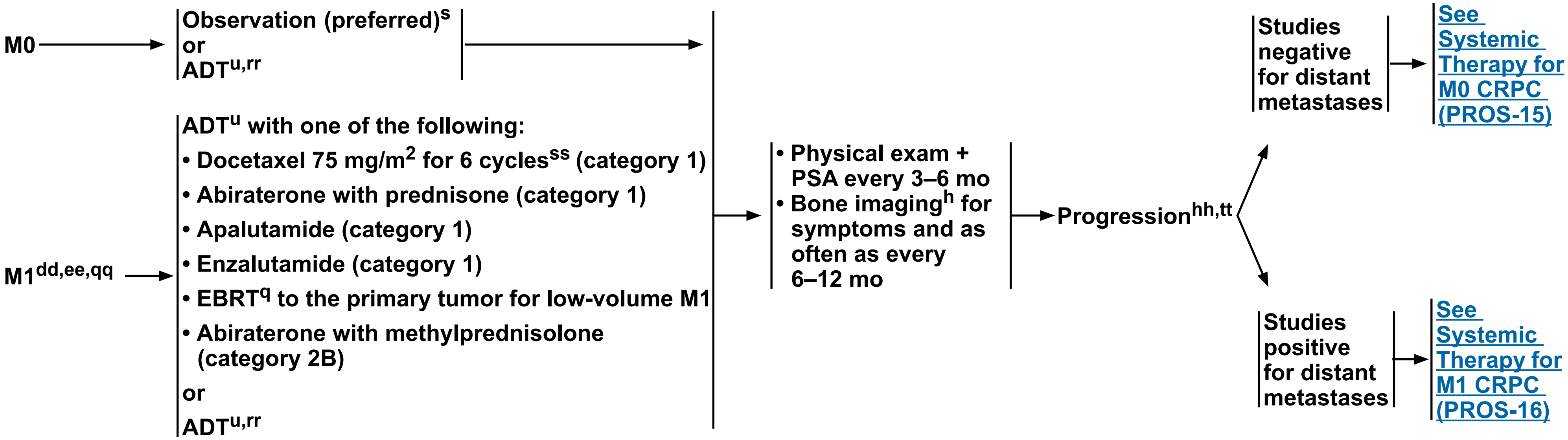
## SYSTEMIC THERAPY FOR CASTRATION-NAIVE DISEASE[jj,pp]



**M0** → **Observation (preferred)[s]** **or** **ADT[u,rr]** →

**M1[dd,ee,qq]** → **ADT[u] with one of the following:**

- **Docetaxel 75 mg/$m^2$ for 6 cycles[ss] (category 1)**
- **Abiraterone with prednisone (category 1)**
- **Apalutamide (category 1)**
- **Enzalutamide (category 1)**
- **EBRT[q] to the primary tumor for low-volume M1**
- **Abiraterone with methylprednisolone (category 2B)**

**or**

**ADT[u,rr]**

→

- **Physical exam + PSA every 3–6 mo**
- **Bone imaging[h] for symptoms and as often as every 6–12 mo**

→ **Progression[hh,tt]**

→ **Studies negative for distant metastases** → **See Systemic Therapy for M0 CRPC (PROS-15)**

→ **Studies positive for distant metastases** → **See Systemic Therapy for M1 CRPC (PROS-16)**

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[h] See Principles of Imaging (PROS-B).

[q] See Principles of Radiation Therapy (PROS-D).

[s] Observation involves monitoring the course of disease with the expectation to deliver palliative therapy for the development of symptoms or a change in exam or PSA that suggests symptoms are imminent. See Principles of Active Surveillance and Observation (PROS-C).

[u] See Principles of Androgen Deprivation Therapy (PROS-F).

[dd] DNA analysis for MSI and IHC for MMR are different assays measuring the same biological effect. If MSI is used, testing using an NGS assay validated for prostate cancer is preferred. If MSI-H or dMMR is found, refer to genetic counseling to assess for the possibility of Lynch syndrome. MSI-H or dMMR indicate eligibility for pembrolizumab in later lines of treatment for CRPC (see PROS-17 and PROS-18). Hempelmann JA, Lockwood CM, Konnick EQ, et al. Microsatellite instability in prostate cancer by PCR or NGS. J Immunother Cancer 2018;6:29.

[ee] Consider evaluating tumor for alterations in homologous recombination DNA repair such as: *BRCA1, BRCA2, ATM, PALB2, FANCA, RAD51D*, and *CHEK2*. At present, this information may be used for genetic counseling, early use of platinum chemotherapy, and/or eligibility for clinical trials (eg, PARP inhibitors). Clinical trials may include additional candidate DNA repair genes under investigation as molecular biomarkers. If mutations in *BRCA2, BRCA1, ATM, CHEK2*, or *PALB2* are found and/or there is a strong family history of cancer, refer to genetic counseling to assess for the possibility of HBOC.

[hh] Workup for progression should include bone imaging, chest CT, and abdominal/pelvic CT or abdominal/pelvic MRI with and without contrast. Consider C-11 choline PET/CT or PET/MRI or F-18 fluciclovine PET/CT or PET/MRI for further soft tissue and bone evaluation or F-18 sodium fluoride PET/CT or PET/MRI for further bone evaluation. The Panel remains unsure what to do when M1 is suggested by modern imaging but not on conventional imaging. See Principles of Imaging (PROS-B) and Discussion.

[jj] The term "castration-naive" is used to define patients who are not on ADT at the time of progression. The NCCN Prostate Cancer Panel uses the term "castration-naive" even when patients have had neoadjuvant, concurrent, or adjuvant ADT as part of radiation therapy provided they have recovered testicular function.

[pp] EBRT to sites of metastases can be considered if metastases are in weight-bearing bones or if the patient is symptomatic.

[qq] ADT alone (see PROS-F) or observation are recommended for asymptomatic patients with metastatic disease and life expectancy ≤5 years.

[rr] Intermittent ADT can be considered for men with M0 or M1 disease to reduce toxicity. See Principles of Androgen Deprivation Therapy (PROS-F).

[ss] High-volume disease is differentiated from low-volume disease by visceral metastases and/or 4 or more bone metastases, with at least one metastasis beyond the pelvis vertebral column. Patients with low-volume disease have less certain benefit from early treatment with docetaxel combined with ADT.

[tt] Assure castrate level of testosterone.

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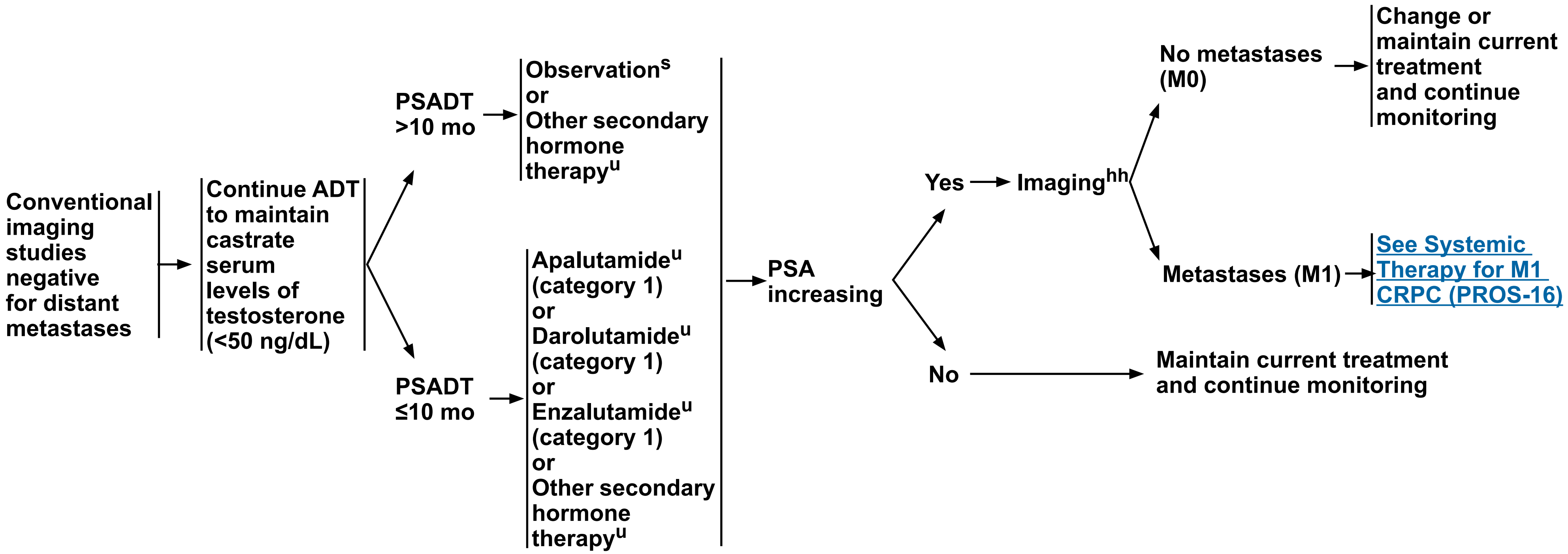
## SYSTEMIC THERAPY FOR M0 CASTRATION–RESISTANT PROSTATE CANCER (CRPC)



**Conventional imaging studies negative for distant metastases** → **Continue ADT to maintain castrate serum levels of testosterone (<50 ng/dL)**

- **PSADT >10 mo** → **Observation[s] or Other secondary hormone therapy[u]**
- **PSADT ≤10 mo** → **Apalutamide[u] (category 1) or Darolutamide[u] (category 1) or Enzalutamide[u] (category 1) or Other secondary hormone therapy[u]**

→ **PSA increasing**

- **Yes** → **Imaging[hh]**
  - **No metastases (M0)** → **Change or maintain current treatment and continue monitoring**
  - **Metastases (M1)** → **See Systemic Therapy for M1 CRPC (PROS-16)**
- **No** → **Maintain current treatment and continue monitoring**

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[s] Observation involves monitoring the course of disease with the expectation to deliver palliative therapy for the development of symptoms or a change in exam or PSA that suggests symptoms are imminent. See Principles of Active Surveillance and Observation (PROS-C).

[u] See Principles of Androgen Deprivation Therapy (PROS-F).

[hh] Workup for progression should include bone imaging, chest CT, and abdominal/pelvic CT or abdominal/pelvic MRI with and without contrast. Consider C-11 choline PET/CT or PET/MRI or F-18 fluciclovine PET/CT or PET/MRI for further soft tissue and bone evaluation or F-18 sodium fluoride PET/CT or PET/MRI for further bone evaluation. The Panel remains unsure what to do when M1 is suggested by modern imaging but not on conventional imaging. See Principles of Imaging (PROS-B) and Discussion.

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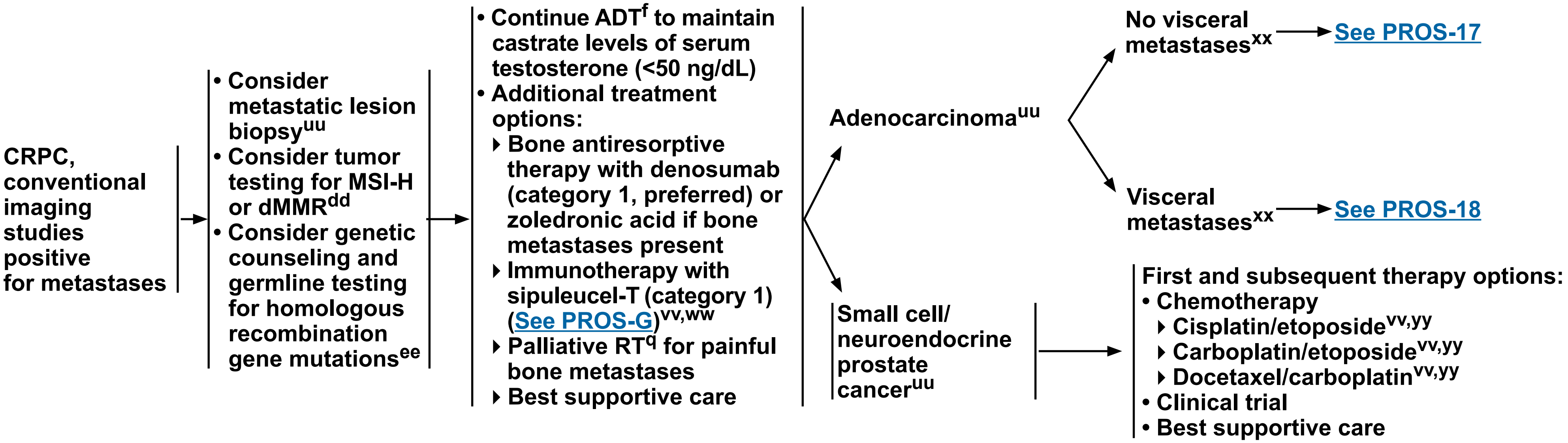
**Clinical Trials: NCCN believes that the best management of any patient with cancer is in a clinical trial. Participation in clinical trials is especially encouraged.**

## SYSTEMIC THERAPY FOR M1 CRPC



**CRPC, conventional imaging studies positive for metastases**

→

- **Consider metastatic lesion biopsy[uu]**
- **Consider tumor testing for MSI-H or dMMR[dd]**
- **Consider genetic counseling and germline testing for homologous recombination gene mutations[ee]**

→

- **Continue ADT[f] to maintain castrate levels of serum testosterone (<50 ng/dL)**
- **Additional treatment options:**
  - **Bone antiresorptive therapy with denosumab (category 1, preferred) or zoledronic acid if bone metastases present**
  - **Immunotherapy with sipuleucel-T (category 1) (See PROS-G)[vv,ww]**
  - **Palliative RT[q] for painful bone metastases**
  - **Best supportive care**

**Adenocarcinoma[uu]**
- **No visceral metastases[xx]** → **See PROS-17**
- **Visceral metastases[xx]** → **See PROS-18**

**Small cell/ neuroendocrine prostate cancer[uu]** →

**First and subsequent therapy options:**
- **Chemotherapy**
  - **Cisplatin/etoposide[vv,yy]**
  - **Carboplatin/etoposide[vv,yy]**
  - **Docetaxel/carboplatin[vv,yy]**
- **Clinical trial**
- **Best supportive care**

---

[f] See Principles of Androgen Deprivation Therapy (PROS-F).

[q] See Principles of Radiation Therapy (PROS-D).

[dd] DNA analysis for MSI and IHC for MMR are different assays measuring the same biological effect. If MSI is used, testing using an NGS assay validated for prostate cancer is preferred. If MSI-H or dMMR is found, refer to genetic counseling to assess for the possibility of Lynch syndrome. MSI-H or dMMR indicate eligibility for pembrolizumab in later lines of treatment for CRPC (see PROS-17 and PROS-18). Hempelmann JA, Lockwood CM, Konnick EQ, et al. Microsatellite instability in prostate cancer by PCR or NGS. J Immunother Cancer 2018;6:29.

[ee] Consider evaluating tumor for alterations in homologous recombination DNA repair such as: *BRCA1, BRCA2, ATM, PALB2, FANCA, RAD51D*, and *CHEK2*. At present, this information may be used for genetic counseling, early use of platinum chemotherapy, and/or eligibility for clinical trials (eg, PARP inhibitors). Clinical trials may include additional candidate DNA repair genes under investigation as molecular biomarkers. If mutations in *BRCA2, BRCA1, ATM, CHEK2*, or *PALB2* are found and/or there is a strong family history of cancer, refer to genetic counseling to assess for the possibility of HBOC.

[uu] Histologic evidence of both adenocarcinoma and small cell carcinoma may be present, in which case treatment can follow either pathway. Treat as adenocarcinoma if biopsy is not feasible or not performed.

[vv] See Principles of Immunotherapy and Chemotherapy (PROS-G).

[ww] Sipuleucel-T has not been studied in patients with visceral metastases. Sipuleucel-T is not recommended for patients with small cell/neuroendocrine prostate cancer.

[xx] Visceral metastases refers to liver, lung, adrenal, peritoneal, and brain metastases. Soft tissue/lymph node sites are not considered visceral metastases.

[yy] See NCCN Guidelines for Small Cell Lung Cancer.

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## SYSTEMIC THERAPY FOR M1 CRPC: ADENOCARCINOMA WITHOUT VISCERAL METASTASES[xx,bbb]

### FIRST-LINE TREATMENT

- Abiraterone[u] with prednisone (category 1)
- Docetaxel[vv,zz] (category 1)
- Enzalutamide[u] (category 1)
- Radium-223[aaa] for symptomatic bone metastases (category 1)
- Abiraterone[u] with methylprednisolone
- Clinical trial
- Other secondary hormone therapy[u]

### SECOND-LINE TREATMENT

**Prior therapy abiraterone/ enzalutamide[ccc,ddd,eee]**

- Docetaxel[vv] (category 1)
- Radium-223[aaa] for symptomatic bone metastases (category 1)
- Pembrolizumab for MSI-H or dMMR[vv] (category 2B)
- If not previously received:
  - Abiraterone[u] with prednisone
  - Abiraterone[u] with methylprednisolone
  - Enzalutamide[u]
  - Sipuleucel-T[vv,ww]
  - Clinical trial
  - Other secondary hormone therapy[u]
  - Best supportive care

**Prior therapy docetaxel[ddd,eee]**

- Abiraterone[u] with prednisone (category 1)
- Cabazitaxel (category 1)[vv]
- Enzalutamide (category 1)[u]
- Radium-223[aaa] for symptomatic bone metastases (category 1)
- Abiraterone[u] with methylprednisolone
- Pembrolizumab for MSI-H or dMMR[vv] (category 2B)
- If not previously received:
  - Sipuleucel-T[vv,ww]
  - Clinical trial
  - Consider docetaxel rechallenge[vv,fff]
  - Mitoxantrone with prednisone[vv,ggg]
  - Other secondary hormone therapy[u]
  - Best supportive care

### SUBSEQUENT TREATMENT

At progression[ddd,eee]:

- If not previously received:
  - Abiraterone[u] with prednisone (category 1)
  - Enzalutamide[u] (category 1)
  - Cabazitaxel[vv] (category 1)
  - Radium-223[aaa] for symptomatic bone metastases (category 1)
  - Abiraterone[u] with methylprednisolone
  - Mitoxantrone with prednisone[vv,ggg]
  - Pembrolizumab for MSI-H or dMMR[vv] (category 2B)
- Clinical trial
- Docetaxel rechallenge[vv,fff]
- Other secondary hormone therapy[u]
- Best supportive care

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[u] See Principles of Androgen Deprivation Therapy (PROS-F).

[vv] See Principles of Immunotherapy and Chemotherapy (PROS-G).

[ww] Sipuleucel-T has not been studied in patients with visceral metastases.

[xx] Visceral metastases refers to liver, lung, adrenal, peritoneal, and brain metastases. Soft tissue/ lymph node sites are not considered visceral metastases.

[zz] Although most patients without symptoms are not treated with chemotherapy, the survival benefit reported for docetaxel applies to those with or without symptoms. Docetaxel may be considered for patients with signs of rapid progression or visceral metastases despite lack of symptoms.

[aaa] Radium-223 is not approved for use in combination with docetaxel or any other chemotherapy. See Principles of Radiation Therapy (PROS-D).

[bbb] Patients can continue through all treatment options listed. Best supportive care is always an appropriate option.

[ccc] Consider AR-V7 testing to help guide selection of therapy (See Discussion).

[ddd] Workup for progression should include chest CT, bone imaging, and abdominal/pelvic CT or abdominal/pelvic MRI with and without contrast. Consider metastatic lesion biopsy. See Principles of Imaging (PROS-B) and Discussion.

[eee] If visceral mets are found, see PROS-18. If small cell neuroendocrine is found, see PROS-16.

[fff] Patients who received docetaxel with ADT in the metastatic castration-naive setting can be considered for docetaxel rechallenge in the CRPC setting.

[ggg] Mitoxantrone with prednisone is for palliation in symptomatic patients who cannot tolerate other therapies.

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## SYSTEMIC THERAPY FOR M1 CRPC: ADENOCARCINOMA WITH VISCERAL METASTASES [xx,bbb]

### FIRST-LINE TREATMENT

- **Docetaxel[vv] (category 1)**
- **Enzalutamide[u] (category 1)**
- **Abiraterone[u] with prednisone**
- **Abiraterone[u] with methylprednisolone**
- **Clinical trial**
- **Mitoxantrone with prednisone[vv,ggg]**
- **Other secondary hormone therapy[u]**

**Prior therapy enzalutamide/ abiraterone[ccc,ddd,hhh]** →

### SECOND-LINE TREATMENT

- **Docetaxel[vv] (category 1)**
- **If not previously received:**
  - **Abiraterone[u] with prednisone**
  - **Abiraterone[u] with methylprednisolone**
  - **Enzalutamide[u]**
  - **Cabazitaxel[vv]**
- **Pembrolizumab for MSI-H or dMMR[vv] (category 2B)**
- **Clinical trial**
- **Other secondary hormone therapy[u]**
- **Best supportive care**

**Prior therapy docetaxel [ddd,hhh]** →

- **Abiraterone[u] with prednisone (category 1)**
- **Enzalutamide[u] (category 1)**
- **Cabazitaxel[vv] (category 1)**
- **Abiraterone[u] with methylprednisolone**
- **Pembrolizumab for MSI-H or dMMR[vv] (category 2B)**
- **Clinical trial**
- **Docetaxel rechallenge[vv,fff]**
- **Mitoxantrone with prednisone[vv,ggg]**
- **Other secondary hormone therapy[u]**
- **Best supportive care**

→

### SUBSEQUENT TREATMENT (category 2B)

**At progression[ddd,hhh]:**

- **If not previously received:**
  - **Enzalutamide[u]**
  - **Cabazitaxel[vv]**
  - **Abiraterone[u] with prednisone**
  - **Abiraterone[u] with methylprednisolone**
  - **Mitoxantrone with prednisone[vv,ggg]**
  - **Pembrolizumab for MSI-H or dMMR[vv]**
- **Clinical trial**
- **Docetaxel rechallenge[vv,fff]**
- **Other secondary hormone therapy[u]**
- **Best supportive care**

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[u] See Principles of Androgen Deprivation Therapy (PROS-F).

[vv] See Principles of Immunotherapy and Chemotherapy (PROS-G).

[xx] Visceral metastases refers to liver, lung, adrenal, peritoneal, and brain metastases. Soft tissue/lymph node sites are not considered visceral metastases.

[bbb] Patients can continue through all treatment options listed. Best supportive care is always an appropriate option.

[ccc] Consider AR-V7 testing to help guide selection of therapy (See Discussion).

[ddd] Workup for progression should include chest CT, bone imaging, and abdominal/ pelvic CT or abdominal/pelvic MRI with and without contrast. Consider metastatic lesion biopsy. See Principles of Imaging (PROS-B) and Discussion.

[fff] Patients who received docetaxel with ADT in the metastatic castration-naive setting can be considered for docetaxel rechallenge in the CRPC setting.

[ggg] Mitoxantrone with prednisone is for palliation in symptomatic patients who cannot tolerate other therapies.

[hhh] Patients treated with systemic therapy for non-visceral metastases (see PROS-17) should proceed to a different subsequent therapy for patients with visceral metastases based on their previous treatment. If small cell neuroendocrine is found, see PROS-16.

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## PRINCIPLES OF LIFE EXPECTANCY ESTIMATION

- **Life expectancy estimation is critical to informed decision-making in prostate cancer early detection and treatment.**

- **Estimation of life expectancy is possible for groups of men but challenging for individuals.**

- **Life expectancy can be estimated using the Social Security Administration tables (www.ssa.gov/OACT/STATS/table4c6.html) or the WHO's Life Tables by country (http://apps.who.int/gho/data/view.main.60000?lang=en).**

- **Life expectancy can then be adjusted using the clinician's assessment of overall health as follows:**
  - **Best quartile of health - add 50%**
  - **Worst quartile of health - subtract 50%**
  - **Middle two quartiles of health - no adjustment**

- **Example of 5-year increments of age are reproduced in the NCCN Guidelines for Older Adult Oncology for life expectancy estimation.**

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## PRINCIPLES OF IMAGING

### Goals of Imaging

- Imaging is performed for the detection and characterization of disease to select treatment or guide change in management.
- Imaging studies should be performed based on the best available clinical evidence and not influenced by business or personal interests of the care provider.
- Imaging techniques can evaluate anatomic or functional parameters.
  - Anatomic imaging techniques include plain film radiographs, ultrasound, CT, and MRI.
  - Functional imaging techniques include radionuclide bone scan, PET/CT, and advanced MRI techniques, such as spectroscopy and diffusion weighted imaging (DWI).

### Efficacy of Imaging

- The utility of imaging for men with early PSA persistence/recurrence after RP depends on risk group prior to operation, pathologic Gleason grade and stage, PSA, and PSA doubling time (PSADT) after recurrence. Low- and intermediate-risk groups with low serum PSAs postoperatively have a very low risk of positive bone scans or CT scans.
- Frequency of imaging should be based on individual risk, age, PSADT, Gleason score, and overall health.
- Conventional bone scans are rarely positive in asymptomatic men with PSA <10 ng/mL. The relative risk for bone metastasis or death increases as PSADT shortens. Bone imaging should be performed more frequently when PSADT ≤8 mo, where there appears to be an inflection point.

### Plain Radiography

- Plain radiography can be used to evaluate symptomatic regions in the skeleton. However, conventional plain x-rays will not detect a bone lesion until nearly 50% of the mineral content of the bone is lost or gained.
- CT or MRI may be more useful to assess fracture risk as these modalities permit more accurate assessment of cortical involvement than plain films where osteoblastic lesions may obscure cortical involvement.

### Ultrasound

- Ultrasound uses high-frequency sound waves to image small regions of the body.
  - Standard ultrasound imaging provides anatomic information.
  - Vascular flow can be assessed using Doppler ultrasound techniques.
- Endorectal ultrasound is used to guide transrectal biopsies of the prostate.
- Endorectal ultrasound can be considered for patients with suspected recurrence after RP.
- Advanced ultrasound techniques for imaging of the prostate and for differentiation between prostate cancer and prostatitis are under evaluation.

### Bone Imaging

- The use of the term “bone scan” refers to the conventional technetium-99m-MDP bone scan in which technetium is taken up by bone that is turning over and imaged with a gamma camera using planar imaging or 3-D imaging with single-photon emission CT (SPECT).
  - Sites of increased uptake imply accelerated bone turnover and may indicate metastatic disease.
  - Osseous metastatic disease may be diagnosed based on the overall pattern of activity, or in conjunction with anatomic imaging.
- Bone scan is indicated in the initial evaluation of patients at high risk for skeletal metastases.
- Bone scan can be considered for the evaluation of the post-prostatectomy patient when there is failure of PSA to fall to undetectable levels, or when there is undetectable PSA after RP with a subsequent detectable PSA that increases on 2 or more subsequent determinations.
- Bone scan can be considered for the evaluation of patients with an increasing PSA or positive DRE after RT if the patient is a candidate for additional local therapy or systemic therapy.

Continued

## PRINCIPLES OF IMAGING

- Bone scans are helpful to monitor metastatic prostate cancer to determine the clinical benefit of systemic therapy. However, new lesions seen on an initial post-treatment bone scan, compared to the pre-treatment baseline scan, may not indicate disease progression.
- New lesions in the setting of a falling PSA or soft tissue response and in the absence of pain progression at that site may indicate bone scan flare or an osteoblastic healing reaction. For this reason, a confirmatory bone scan 8–12 weeks later is warranted to determine true progression from flare reaction. Additional new lesions favor progression. Stable scans make continuation of treatment reasonable. Bone scan flare is common, particularly on initiation of new hormonal therapy, and may be observed in nearly half of patients treated with the newer agents, enzalutamide and abiraterone. Similar flare phenomena may exist with other imaging modalities, such as CT or PET/CT imaging.
- Bone scans and soft tissue imaging (CT or MRI) in men with metastatic prostate cancer or non-metastatic progressive prostate cancer may be obtained regularly during systemic therapy to assess clinical benefit.
- Bone scans should be performed for symptoms and as often as every 6–12 mo to monitor ADT. The need for soft tissue images remains unclear. In CRPC, 8- to 12-week imaging intervals appear reasonable.
- PET/CT for detection of bone metastatic disease M0 CRPC
  - F-18 sodium fluoride PET/CT or PET/MRI may be used to detect bone metastatic disease with greater sensitivity but less specificity than standard bone scan imaging.
  - Plain films, CT, MRI, F-18 sodium fluoride PET/CT or PET/MRI, C-11 choline PET/CT or PET/MRI, or F-18 fluciclovine PET/CT or PET/MRI can be considered for equivocal results on initial bone scan.
- Earlier detection of bone metastatic disease may result in earlier use of newer and more expensive therapies, which may not improve oncologic outcomes or overall survival.

### Computed Tomography

- CT provides a high level of anatomic detail, and may detect gross extracapsular disease, nodal metastatic disease, and/or visceral metastatic disease.
- CT is generally not sufficient to evaluate the prostate gland.
- CT may be performed with and without oral and intravenous contrast, and CT technique should be optimized to maximize diagnostic utility while minimizing radiation dose.
- CT can be used for examination of the pelvis and/or abdomen for initial evaluation (see PROS-2) and as part of workup for recurrence or progression (see PROS-12 through PROS-18).

### Magnetic Resonance Imaging

- The strengths of MRI include high soft tissue contrast and characterization, multiparametric image acquisition, multiplanar imaging capability, and advanced computational methods to assess function.
  - MRI can be performed with and without the administration of intravenous contrast material.
  - Resolution of MRI images in the pelvis can be augmented using an endorectal coil.
- Standard MRI techniques can be used for examination of the pelvis and/or abdomen for initial evaluation (see PROS-2) and as part of workup for recurrence or progression (see PROS-12 through PROS-18).
- MRI may be considered in patients after RP when PSA fails to fall to undetectable levels or when an undetectable PSA becomes detectable and increases on 2 or more subsequent determinations, or after RT for rising PSA or positive DRE if the patient is a candidate for additional local therapy. MRI-US fusion biopsy may improve the detection of higher grade (Grade Group ≥ 2) cancers.
- Multiparametric MRI (mpMRI) can be used in the staging and characterization of prostate cancer. mpMRI images are defined as images acquired with at least one more sequence in addition to the anatomical T2-weighted images, such as DWI or dynamic contrast-enhanced (DCE) images.

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Continued

## PRINCIPLES OF IMAGING

- mpMRI may be used to better risk stratify men who are considering active surveillance. Additionally, mpMRI may detect large and poorly differentiated prostate cancer (Grade Group ≥ 2) and detect extracapsular extension (T staging). mpMRI has been shown to be equivalent to CT scan for pelvic lymph node evaluation.

Positron Emission Tomography (PET)

- F-18 fluorodeoxyglucose (FDG) PET/CT should not be used routinely for staging prostate cancer since data are limited in patients with prostate cancer.
- The use of PET/CT or PET/MRI imaging using tracers other than F-18 FDG for staging of small volume recurrent or metastatic prostate cancer is a rapidly developing field wherein most of the data are derived from single institution series or registry studies. FDA clearance and reimbursement for some tests makes unlikely the conduct of clinical trials to evaluate their utility and impact upon oncologic outcome.
- PET/CT or PET/MRI for detection of biochemically recurrent disease.
  - C-11 choline or F-18 fluciclovine PET/CT or PET/MRI may be used to detect small volume disease in soft tissues and in bone.
  - Histologic confirmation is recommended whenever feasible due to significant rates of false positivity.
  - High variability among PET/CT or PET/MRI equipment, protocols, interpretation, and institutions provides challenges for application and interpretation of the utility of PET/CT or PET/MRI.
  - Table 2 (see Discussion) provides a summary of the main PET/CT or PET/MRI imaging tracers utilized for study in prostate cancer recurrence after operation or radiation.
  - PET/CT or PET/MRI results may change treatment but may not change oncologic outcome.
  - When the worst prognosis patients from one risk group move to the higher risk group, the average outcome of both risk groups will improve even if treatment has no impact on disease. This phenomenon is known as the Will Rogers effect, in which the improved outcomes of both groups could be falsely attributed to improvement in treatment, but would be due only to improved risk group assignment. As an example, F-18 sodium fluoride PET/CT may categorize some patients as M1b who would have been categorized previously as M0 using a bone scan (stage migration). Absent any change in the effectiveness of therapy, the overall survival of both M1b and M0 groups would improve. The definition of M0 and M1 disease for randomized clinical trials that added docetaxel or abiraterone to ADT was based on CT and conventional radionuclide bone scans. Results suggest that overall survival of M1 disease is improved whereas progression-free but not overall survival of M0 disease is improved. Therefore, a subset of patients now diagnosed with M1 disease using F-18 sodium fluoride PET/CT might not benefit from the more intensive therapy used in these trials and could achieve equivalent overall survival from less intensive therapy aimed at M0 disease. Carefully designed clinical trials using proper staging will be necessary to prove therapeutic benefit, rather than making assumptions compromised by stage migration.

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## PRINCIPLES OF ACTIVE SURVEILLANCE AND OBSERVATION

- The NCCN Prostate Cancer Panel and the NCCN Prostate Cancer Early Detection Panel (See NCCN Guidelines for Prostate Cancer Early Detection) remain concerned about overdiagnosis and overtreatment of prostate cancer. The panel recommends that patients and their physicians (ie, urologist, radiation oncologist, medical oncologist, primary care physician) consider active surveillance based on careful consideration of the patient's prostate cancer risk profile, age, and health.
- The NCCN Guidelines for Prostate Cancer distinguish between active surveillance and observation. Both involve no more often than every-6-month monitoring but active surveillance may involve surveillance prostate biopsies. Evidence of progression will prompt conversion to potentially curative treatment in active surveillance patients, whereas monitoring continues until symptoms develop or are imminent (ie, PSA >100 ng/mL) in observation patients, who will then begin palliative ADT.
- Active surveillance is preferred for men with very-low-risk prostate cancer and life expectancy ≥20 y and for men with low-risk prostate cancer and life expectancy ≥10 y. Observation is preferred for men with low-risk prostate cancer with life expectancy <10 y. See Risk Group Criteria (PROS-2).
- Patients with favorable intermediate-risk prostate cancer (See Risk Group Criteria [PROS-2]) may be considered for active surveillance. See Discussion. Active surveillance involves actively monitoring the course of disease with the expectation to intervene with curative intent if the cancer progresses.
- Cancer progression may have occurred if:
  - Gleason Grade 4 or 5 cancer is found upon repeat prostate biopsy
  - Prostate cancer is found in a greater number of prostate biopsies or occupies a greater extent of prostate biopsy.
- Observation involves monitoring the course of disease with the expectation to deliver palliative therapy for the development of symptoms or change in exam or PSA levels that suggest symptoms are imminent.
- Patients with clinically localized prostate cancers who are candidates for definitive treatment and choose active surveillance should have regular follow-up. Follow-up should be more rigorous in younger men than in older men. Follow-up should include:
  - Consider mpMRI and/or prostate biopsy to confirm candidacy for active surveillance
  - PSA no more often than every 6 mo unless clinically indicated
  - DRE no more often than every 12 mo unless clinically indicated
  - Repeat prostate biopsy no more often than every 12 mo unless clinically indicated
  - Repeat mpMRI no more often than every 12 mo unless clinically indicated
  - Needle biopsy of the prostate should be repeated within 6 mo of diagnosis if initial biopsy was <10 cores or assessment discordant (eg, palpable tumor contralateral to side of positive biopsy)
  - MRI-US fusion biopsy may improve the detection of higher grade (Grade Group ≥2) cancers.
  - A repeat prostate biopsy should be considered if prostate exam changes, MRI suggests more aggressive disease, or PSA increases, but no parameter is very reliable for detecting prostate cancer progression.
  - A repeat prostate biopsy should be considered no more often then annually to assess for disease progression, because PSA kinetics may not be as reliable for predicting progression.
  - Repeat prostate biopsies are not indicated when life expectancy is less than 10 y or appropriate when men are on observation.
  - PSADT appears unreliable for identification of progressive disease that remains curable.

Continued

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## PRINCIPLES OF ACTIVE SURVEILLANCE AND OBSERVATION

- **Advantages of active surveillance:**
  - **About 2/3 of men eligible for active surveillance will avoid treatment**
  - **Avoidance of possible side effects of definitive therapy that may be unnecessary**
  - **Quality of life/normal activities potentially less affected**
  - **Risk of unnecessary treatment of small, indolent cancers reduced**
- **Disadvantages of active surveillance:**
  - **Chance of missed opportunity for cure although very low**
  - **About 1/3 of men will require treatment, although treatment delays do not seem to impact cure rate.**
  - **Periodic follow-up mpMRI and prostate biopsies may be necessary.**
- **Advantages of observation:**
  - **Avoidance of possible side effects of unnecessary definitive therapy and early initiation and/or continuous ADT**
- **Disadvantages of observation:**
  - **Risk of urinary retention or pathologic fracture without prior symptoms or concerning PSA levels**

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## PRINCIPLES OF RADIATION THERAPY

### Definitive Radiation Therapy General Principles

- Highly conformal RT techniques should be used to treat localized prostate cancer.
- Photon or proton EBRT are both effective at achieving highly conformal radiotherapy with acceptable and similar biochemical control and long-term side effect profiles (See Discussion).
- Brachytherapy boost, when added to EBRT plus ADT in men with NCCN intermediate and high/very high risk prostate cancer, has demonstrated improved biochemical control over EBRT plus ADT alone in randomized trials, but with higher toxicity.
- Ideally, the accuracy of treatment should be verified by daily prostate localization, with any of the following: techniques of IGRT using CT, ultrasound, implanted fiducials, or electromagnetic targeting/tracking. Endorectal balloons may be used to improve prostate immobilization. Perirectal spacer materials may be employed when the previously mentioned techniques are insufficient to improve oncologic cure rates and/or reduce side effects due to anatomic geometry or other patient related factors, such as medication usage and/or comorbid conditions. Patients with obvious rectal invasion or visible T3 and posterior extension should not undergo perirectal spacer implantation.
- Various fractionation and dose regimens can be considered depending on the clinical scenario (See Table 1). Dose escalation has been proven to achieve the best biochemical control in men with intermediate and high risk disease.
- SBRT is acceptable in practices with appropriate technology, physics, and clinical expertise.
- Biologically effective dose (BED) modeling with the linear-quadratic equation may not be accurate for extremely hypofractionated (SBRT/SABR) radiation.
- For brachytherapy:
    - Patients with a very large prostate or very small prostate, symptoms of bladder outlet obstruction (high IPSS), or a previous TURP are more difficult to implant and may suffer increased risk of side effects. Neoadjuvant ADT may be used to shrink the prostate to an acceptable size; however, increased toxicity would be expected from ADT and prostate size may not decline in some men despite neoadjuvant ADT. Potential toxicity of ADT must be balanced against the potential benefit of target reduction.
    - Post-implant dosimetry must be performed to document the quality of the low dose-rate implant.

### Definitive Radiation Therapy by Risk Group

- Very low risk
    - Men with NCCN very low risk prostate cancer are encouraged to pursue active surveillance.
- Low risk
    - Men with NCCN low-risk prostate cancer are encouraged to pursue active surveillance.
    - Prophylactic lymph node radiation should NOT be performed routinely. ADT or antiandrogen therapy should NOT be used routinely
- Favorable intermediate risk
    - Prophylactic lymph node radiation is not performed routinely, and ADT or antiandrogen therapy is not used routinely. Prophylactic lymph node radiation and/or ADT use is reasonable if additional risk assessments suggest aggressive tumor behavior.

Continued

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## PRINCIPLES OF RADIATION THERAPY

- Unfavorable intermediate risk
  - Prophylactic nodal radiation can be considered if additional risk assessments suggest aggressive tumor behavior. ADT should be used unless additional risk assessments suggest less-aggressive tumor behavior or if medically contraindicated. The duration of ADT can be reduced when combined with EBRT and brachytherapy. Brachytherapy combined with ADT (without EBRT), or SBRT combined with ADT can be considered when delivering longer courses of EBRT would present medical or social hardship.
- High risk
  - Prophylactic nodal radiation can be considered. ADT is required unless medically contraindicated. The duration of ADT may be reduced when EBRT is combined with brachytherapy. Brachytherapy combined with ADT (without EBRT), or SBRT combined with ADT, can be considered when delivering longer courses of EBRT would present a medical or social hardship.
- Very high risk
  - Prophylactic nodal radiation should be considered. ADT is required unless medically contraindicated.
- Regional disease
  - Nodal radiation should be performed. Clinically positive nodes should be dose-escalated as dose-volume histogram parameters allow. ADT is required unless medically contraindicated, and the addition of abiraterone and prednisone or abiraterone with methylprednisolone (category 2B) to ADT can be considered.
- Low-volume metastatic disease
  - Radiation therapy to the prostate is an option in patients with low-volume castration-naive metastatic disease, without contraindications to radiotherapy. ADT is required unless medically contraindicated.
  - This recommendation is based on the STAMPEDE phase 3 randomized trial, which randomized 2,061 men to standard systemic therapy with or without radiotherapy to the primary. The overall cohort had a significant improvement from the addition of radiotherapy to the primary in failure-free survival, but not overall survival. The prespecified low-volume subset had a significant improvement in both failure-free survival and overall survival.
  - Minimizing toxicity is paramount when delivering radiation therapy to the primary in patients with metastatic disease.
  - Whether treatment of regional nodes in addition to the primary improves outcomes remains uncertain; nodal treatment should be performed in the context of a clinical trial.
  - Dose escalation beyond biologically effective dose equivalents of the two dose prescriptions used in STAMPEDE (55 Gy in 20 fractions or 6 Gy x 6 fractions) is not recommended given the known increase in toxicity from dose intensification without overall survival improvement in localized disease.
  - Brachytherapy is not recommended outside of a clinical trial as safety and efficacy have not been established in this patient population.
- High-volume metastatic disease
  - Radiation therapy to the prostate should NOT be performed in men with high-volume metastatic disease outside the context of a clinical trial unless for palliative intent.
  - This recommendation is based on two randomized trials, HORRAD and STAMPEDE, neither of which showed an improvement in overall survival from the addition of radiotherapy to the primary when combined with standard systemic therapy.

Continued

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## PRINCIPLES OF RADIATION THERAPY

**Table 1: Regimens that have shown acceptable efficacy and toxicity. The optimal regimen for an individual patient warrants evaluation of comorbid conditions, voiding symptoms and toxicity of therapy. Additional fractionation schemes may be used as long as sound oncologic principles and appropriate estimate of BED are considered.**

| **Regimen for Definitive Therapy** | **NCCN Risk Group** (✓ indicates an appropriate regimen option if radiation therapy is given) | | | | | |
|---|---|---|---|---|---|---|
| | **Very Low[a]** | **Low[a]** | **Favorable or Good Prognostic[b] Intermediate** | **Unfavorable, or Poor Prognostic[b], Intermediate** | **High and Very High[c]** | **Node Positive** |
| **Beam Therapies** | | | | | | |
| 72–80 Gy at 2 Gy per fraction | ✓ | ✓ | ✓ | ✓ ± 4 mo ADT | ✓ with 1.5–3 y ADT | ✓ with ADT |
| 75.6–81.0 Gy at 1.8 Gy per fraction | ✓ | ✓ | ✓ | ✓ ± 4 mo ADT | ✓ with 1.5–3 y ADT | ✓ with ADT |
| 70.2 Gy at 2.7 Gy per fraction | ✓ | ✓ | ✓ | ✓ ± 4 mo ADT | ✓ with 1.5–3 y ADT | ✓ with ADT |
| 70 Gy at 2.5 Gy per fraction | ✓ | ✓ | ✓ | ✓ ± 4 mo ADT | ✓ with 1.5–3 y ADT | ✓ with ADT |
| 60 Gy at 3 Gy per fraction | ✓ | ✓ | ✓ | ✓ ± 4 mo ADT | ✓ with 1.5–3 y ADT | ✓ with ADT |
| 51.6 Gy at 4.3 Gy per fraction | ✓ | ✓ | ✓ | | | |
| 37 Gy at 7.4 Gy per fraction | ✓ | ✓ | ✓ | | | |
| 40 Gy at 8 Gy per fraction | ✓ | ✓ | ✓ | | | |
| 36.25 Gy at 7.25 Gy per fraction | ✓ | ✓ | ✓ | | | |
| **Brachytherapy Monotherapy** | | | | | | |
| Iodine 125 implant at 145 Gy | ✓ | ✓ | ✓ | | | |
| Palladium 103 implant at 125 Gy | ✓ | ✓ | ✓ | | | |
| Cesium implant at 115 Gy | ✓ | ✓ | ✓ | | | |
| HDR 27 Gy at 13.5 Gy in 2 implants | ✓ | ✓ | ✓ | | | |
| HDR 38 Gy at 9.5 Gy BID in 2 implants | ✓ | ✓ | ✓ | | | |
| **Combined EBRT and Brachytherapy (EBRT 45–50.4 Gy at 1.8–2.0 Gy/fx, unless otherwise noted)** | | | | | | |
| Iodine 125 implant at 110–115 Gy | | | | ✓ ± 4 mo ADT | ✓ with 1–3 y ADT | |
| Palladium 103 implant at 90–100 Gy | | | | ✓ ± 4 mo ADT | ✓ with 1–3 y ADT | |
| Cesium implant at 85 Gy | | | | ✓ ± 4 mo ADT | ✓ with 1–3 y ADT | |
| HDR 21.5 Gy at 10.75 Gy x 2 | | | | ✓ ± 4 mo ADT | ✓ with 1–3 y ADT | |
| EBRT 37.5 Gy at 2.5 Gy + 12–15 Gy single HDR | | | | ✓ ± 4 mo ADT | ✓ with 1–3 y ADT | |

[a] Active surveillance is preferred for men with very low risk and life expectancy ≥20 y and for men with low risk and life expectancy ≥10 y.
[b] "Good" or "Poor" prognostic is not strictly defined. Predictive nomograms and/or molecular testing can be used to prognosticate PSA persistence/recurrence, prostate cancer-specific mortality, and metastasis-free survival after definitive external beam radiation therapy. Although the prognostic value has been established, the predictive value of these tests remains unknown.
[c] Prophylactic nodal radiation may be considered if estimate of nodal metastasis is high.

Continued

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## PRINCIPLES OF RADIATION THERAPY

**Salvage Brachytherapy**

- Permanent LDR or temporary HDR brachytherapy is a treatment option for pathologically confirmed local recurrence after EBRT or brachytherapy. Subjects should have restaging imaging according to the NCCN high-risk stratification group to rule out regional nodal or metastatic disease. Patients should be counseled that salvage brachytherapy significantly increases the probability of urologic, sexual, and bowel toxicity compared to primary brachytherapy.

**Post-Prostatectomy Radiation Therapy**

- The panel recommends use of nomograms and consideration of age and comorbidities, clinical and pathologic information, PSA levels, and PSADT to individualize treatment discussion. The panel recommends consultation with the American Society for Radiation Oncology (ASTRO)/AUA Guidelines. Evidence supports offering adjuvant/salvage RT in most men with adverse pathologic features or detectable PSA and no evidence of disseminated disease.
- Indications for adjuvant RT include pT3 disease, positive margin(s), or seminal vesicle involvement. Adjuvant RT is usually given within 1 year after RP and after operative side effects have improved/stabilized. Patients with positive surgical margins may benefit the most.
- Indications for salvage RT include an undetectable PSA that becomes subsequently detectable and increases on 2 measurements or a PSA that remains persistently detectable after RP. Treatment is more effective when pre-treatment PSA is low and PSADT is long.
- The recommended prescribed doses for adjuvant/salvage post-prostatectomy RT are 64–72 Gy in standard fractionation. Biopsy-proven gross recurrence may require higher doses.
- EBRT with two years of anti-androgen therapy with 150 mg/daily of bicalutamide demonstrated improved overall and metastasis-free survival on a prospective randomized trial (RTOG 9601) versus radiation alone in the salvage setting. EBRT with 6 months of ADT improved biochemical or clinical progression at 5 years on a prospective randomized trial (GETUG-16) versus radiation alone.
- Nuclear medicine advanced imaging techniques can be useful for localizing disease with PSA levels as low as 0.5 ng/mL (see Discussion)
- Nomograms, and tumor-based molecular assays, can be used to prognosticate risk of metastasis and prostate cancer-specific mortality in men with adverse risk features after RP.
- Target volumes include the prostate bed and may include the whole pelvis according to physician discretion.

**Oligometastatic and Palliative Radiotherapy**

- 8 Gy as a single dose is as effective for pain palliation at any bony site as longer courses of radiation, but re-treatment rates are higher.
- Widespread bone metastases can be palliated using strontium-89 or samarium-153 with or without focal external beam radiation.
- SBRT can be considered, and enrollment on clinical trials is encouraged for oligometastatic disease where durable local control is desirable.
- Treatment of the primary site in men with metastatic disease can be used to palliate obstructive symptoms due to tumor. Definitive external beam dosing regimens, or traditional palliative regimens (eg, 30 Gy/10 fx or 37.5 Gy/15 fx), can be used depending on clinical scenario.

Continued

## PRINCIPLES OF RADIATION THERAPY

### Radiopharmaceutical Therapy

- Radium-223 is an alpha-emitting radiopharmaceutical that has been shown to extend survival in men who have castration-resistant prostate cancer (CRPC) with symptomatic bone metastases, but no visceral metastases. Radium-223 alone has not been shown to extend survival in men with visceral metastases or bulky nodal disease (>3 to 4 cm). Radium-223 differs from beta-emitting agents, such as samarium 153 and strontium 89, which are palliative and have no survival advantage. Radium-223 causes double-strand DNA breaks and has a short radius of activity. Grade 3–4 hematologic toxicity (2% neutropenia, 3% thrombocytopenia, 6% anemia) occurs at low frequency.
- Radium-223 is administered intravenously once a month for 6 months by an appropriately licensed facility, usually in nuclear medicine or RT departments.
- Prior to the initial dose, patients must have absolute neutrophil count $\geq 1.5 \times 10^9$/L, platelet count $\geq 100 \times 10^9$/L, and hemoglobin ≥10 g/dL.
- Prior to subsequent doses, patients must have absolute neutrophil count $\geq 1 \times 10^9$/L and platelet count $\geq 50 \times 10^9$/L (per label, although this may be too low in practice). Radium-223 should be discontinued if a delay of 6–8 weeks does not result in the return of blood counts to these levels.
- Non-hematologic side effects are generally mild, and include nausea, diarrhea, and vomiting. These symptoms may occur because radium-223 is eliminated predominantly by fecal excretion.
- Radium-223 is not intended to be used in combination with chemotherapy due to the potential for additive myelosuppression, except in a clinical trial.
- Concomitant use of denosumab or zoledronic acid does not interfere with the beneficial effects of radium-223 on survival.

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## PRINCIPLES OF SURGERY

### Pelvic Lymph Node Dissection

- An extended PLND will discover metastases approximately twice as often as a limited PLND. Extended PLND provides more complete staging and may cure some men with microscopic metastases; therefore, an extended PLND is preferred when PLND is performed.
- An extended PLND includes removal of all node-bearing tissue from an area bound by the external iliac vein anteriorly, the pelvic sidewall laterally, the bladder wall medially, the floor of the pelvis posteriorly, Cooper's ligament distally, and the internal iliac artery proximally.
- A PLND can be excluded in patients with <2% predicated probability of nodal metastases by nomograms, although some patients with lymph node metastases will be missed.
- PLND can be performed using an open, laparoscopic, or robotic technique.

### Radical Prostatectomy

- RP is an appropriate therapy for any patient with clinically localized prostate cancer that can be completely excised surgically, who has a life expectancy of ≥10 years, and who has no serious comorbid conditions that would contraindicate an elective operation.
- High-volume surgeons in high-volume centers generally provide better outcomes.
- Laparoscopic and robot-assisted RP are commonly used. In experienced hands, the results of these approaches appear comparable to open surgical approaches.
- Blood loss can be substantial with RP, but can be reduced by using laparoscopic or robotic assistance or by careful control of the dorsal vein complex and periprostatic vessels when performed open.
- Urinary incontinence can be reduced by preservation of urethral length beyond the apex of the prostate and avoiding damage to the distal sphincter mechanism. Bladder neck preservation may decrease the risk of incontinence. Anastomotic strictures increase the risk of long-term incontinence.
- Recovery of erectile function is directly related to age at RP, preoperative erectile function, and the degree of preservation of the cavernous nerves. Replacement of resected nerves with nerve grafts has not been shown to be beneficial. Early restoration of erections may improve late recovery.
- Salvage RP is an option for highly selected patients with local recurrence after EBRT, brachytherapy, or cryotherapy in the absence of metastases, but the morbidity (ie, incontinence, loss of erection, anastomotic stricture) is high and the operation should be performed by surgeons who are experienced with salvage RP.

## PRINCIPLES OF ANDROGEN DEPRIVATION THERAPY

### ADT for Clinically Localized (N0M0) Disease

- Neoadjuvant ADT for RP is strongly discouraged outside of a clinical trial.
- ADT should not be used as monotherapy in clinically localized prostate cancer unless there is a contraindication to definitive local therapy such as life expectancy ≤5 years and comorbidities. Under those circumstances, ADT may be an acceptable alternative if the disease is high or very high risk.
- Giving ADT before, during, and/or after radiation (neoadjuvant, concurrent, and/or adjuvant ADT) prolongs survival in selected radiation-managed patients. Options are:
  - LHRH agonist alone
    - Goserelin, histrelin, leuprolide, or triptorelin
  - LHRH agonist (as above) plus first-generation antiandrogen
    - Nilutamide, flutamide, or bicalutamide
  - LHRH antagonist
    - Degarelix
- Studies of short-term (4–6 mo) and long-term (2–3 y) neoadjuvant, concurrent, and/or adjuvant ADT all have used complete androgen blockade. Whether the addition of an antiandrogen is necessary requires further study.
- The largest randomized trial to date using the antiandrogen bicalutamide alone at high dose (150 mg) showed a delay in recurrence of disease but no improvement in survival; however, longer follow-up is needed.

### ADT for Regional (N1M0) Disease

- Patients with N1M0 prostate cancer and a life expectancy >5 y can be treated with EBRT and neoadjuvant, concurrent, and/or adjuvant ADT as for patients with N0M0 disease (see above) or they can be treated with ADT alone or with abiraterone. Abiraterone should be given with concurrent steroid, either prednisone 5 mg orally once daily or methylprednisolone 4 mg orally twice daily depending on the formulation of abiraterone used (category 2B for abiraterone with methylprednisolone). Abiraterone with either steroid should not be given following progression on abiraterone with the other steroid.
- Abiraterone with prednisone can be administered at a dose of 250 mg/day following a low-fat breakfast, as an alternative to the dose of 1000 mg/day after an overnight fast. The cost savings from this dosing may reduce financial toxicity and improve compliance. Szmulewitz RZ, Peer CJ, Ibraheem A, et al. Prospective international randomized phase II study of low-dose abiraterone with food versus standard dose abiraterone In castration-resistant prostate cancer. J Clin Oncol 2018;36:1389-1395.
- Options for ADT alone or with abiraterone are:
  - Orchiectomy
  - LHRH agonist alone
    - Goserelin, histrelin, leuprolide, or triptorelin
  - LHRH agonist (as above) plus first-generation antiandrogen
    - Nilutamide, flutamide, or bicalutamide
  - LHRH antagonist
    - Degarelix (category 2B)
  - Orchiectomy plus abiraterone
  - LHRH agonist (as above) plus abiraterone
  - LHRH antagonist (as above) plus abiraterone
- In one randomized trial, immediate and continuous use of ADT in men with positive nodes following RP resulted in significantly improved overall survival compared to men who received delayed ADT. Therefore, such patients should be considered for immediate LHRH agonist, LHRH antagonist (category 2B for LHRH antagonist), or orchiectomy. Many of the side effects of continuous ADT are cumulative over time on ADT.

Continued

Note: All recommendations are category 2A unless otherwise indicated.
Clinical Trials: NCCN believes that the best management of any patient with cancer is in a clinical trial. Participation in clinical trials is especially encouraged.

## PRINCIPLES OF ANDROGEN DEPRIVATION THERAPY

### ADT for M0 PSA Persistence/Recurrence After RP or EBRT (ADT for M0 Castration-Naive Disease)

- The timing of ADT for patients whose only evidence of cancer after definitive treatment is an increasing PSA is influenced by PSA velocity, patient anxiety, the short- and long-term side effects of ADT, and the underlying comorbidities of the patient.
- Most patients will have a good 15-year prognosis, but their prognosis is best approximated by the absolute level of PSA, the rate of change in the PSA level (PSADT), and the initial stage, grade, and PSA level at the time of definitive therapy.
- Earlier ADT may be better than delayed ADT, although the definitions of early and late (what level of PSA) are controversial. Since the benefit of early ADT is not clear, treatment should be individualized until definitive studies are done. Patients with a shorter PSADT (or a rapid PSA velocity) and an otherwise long life expectancy should be encouraged to consider ADT earlier.
- Some patients are candidates for salvage therapy after PSA persistence/recurrence. See PROS-12 and PROS-13.
- Men with prolonged PSADTs (>12 mo) and who are older are candidates for observation.
- Men who choose ADT should consider intermittent ADT. A phase 3 trial that compared intermittent to continuous ADT showed that intermittent ADT was not inferior to continuous ADT with respect to survival, and quality of life was better for the intermittent ADT arm. The 7% increase in prostate cancer deaths in the intermittent ADT arm was balanced by more non-prostate cancer deaths in the continuous ADT arm. An unplanned subset analysis showed that men with Grade Group 4 or 5 prostate cancer in the continuous arm had a median overall survival that was 14 mo longer (8 y) than those in the intermittent arm (6.8 y).
- ADT options are:
  - ▸ M0 RP PSA Persistence/Recurrence:
    - ◊ EBRT +/- neoadjuvant, concurrent, and/or adjuvant ADT [See ADT for Clinically Localized (N0M0) Disease]
  - ▸ M0 EBRT PSA Persistence/Recurrence, TRUS-biopsy negative or M0 PSA Persistence/Recurrence after progression on salvage EBRT:
    - ◊ Orchiectomy
    - ◊ LHRH agonist alone
      - – Goserelin, histrelin, leuprolide, or triptorelin
    - ◊ LHRH agonist (as above) plus first-generation antiandrogen
      - – Nilutamide, flutamide, or bicalutamide
    - ◊ LHRH antagonist
      - – Degarelix

### ADT for Metastatic Castration-Naive Disease

- ADT is the gold standard for men with metastatic prostate cancer.
- A phase 3 trial compared continuous ADT to intermittent ADT, but the study could not demonstrate non-inferiority for survival. However, quality-of-life measures for erectile function and mental health were better in the intermittent ADT arm after 3 months of ADT compared to the continuous ADT arm.
- In addition, three meta-analyses of randomized controlled trials failed to show a difference in survival between intermittent and continuous ADT.
- Close monitoring of PSA and testosterone levels and possibly imaging is required when using intermittent ADT, especially during off-treatment periods, and patients may need to switch to continuous ADT upon signs of disease progression.
- Treatment options for men with M1 castration-naive disease are:
  - ▸ Orchiectomy ± docetaxel
  - ▸ LHRH agonist alone ± docetaxel (a first-generation antiandrogen must be given for ≥7 days to prevent testosterone flare if metastases are present in weightbearing bone)
    - ◊ Goserelin, histrelin, leuprolide, or triptorelin
  - ▸ LHRH agonist (as above) plus first-generation antiandrogen ± docetaxel
    - ◊ Nilutamide, flutamide, or bicalutamide
  - ▸ LHRH antagonist ± docetaxel
    - ◊ Degarelix
  - ▸ Orchiectomy plus abiraterone, enzalutamide, or apalutamide
  - ▸ LHRH agonist (as above) plus abiraterone, enzalutamide, or apalutamide
  - ▸ LHRH antagonist (as above) plus abiraterone, enzalutamide, or apalutamide
- Abiraterone with prednisone can be administered at a dose of 250 mg/day following a low-fat breakfast, as an alternative to the dose of 1000 mg/day after an overnight fast. The cost savings from this dosing may reduce financial toxicity and improve compliance. Szmulewitz RZ, Peer CJ, Ibraheem A, et al. Prospective international randomized phase II study of low-dose abiraterone with food versus standard dose abiraterone in castration-resistant prostate cancer. J Clin Oncol 2018;36:1389-1395.

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Continued

## PRINCIPLES OF ANDROGEN DEPRIVATION THERAPY

- Two randomized phase 3 clinical trials of abiraterone with prednisone plus ADT in men with castration-naïve metastatic prostate cancer demonstrated improved OS over ADT alone. Adverse events were higher with abiraterone and prednisone but were generally mild in nature and were largely related to mineralocorticoid excess (ie, hypertension, hypokalemia, edema), hormonal effects (ie, fatigue, hot flushes), and liver toxicity. Cardiac events, severe hypertension, and liver toxicity were increased with abiraterone.
- A double-blind randomized phase 3 clinical trial of apalutamide plus ADT in men with castration-naïve metastatic prostate cancer demonstrated improved OS over ADT alone. Adverse events that were more common with apalutamide than with placebo included rash, hypothyroidism, and ischemic heart disease.
- An open-label randomized phase 3 clinical trial of enzalutamide plus ADT in men with castration-naïve metastatic prostate cancer demonstrated improved OS over ADT alone. In a separate double-blind randomized phase 3 clinical, enzalutamide reduced the risk of metastatic progression or death compared with placebo. Adverse events associated with enzalutamide included fatigue, seizures, and hypertension.

<u>Secondary Hormone Therapy for M0 or M1 CRPC</u>

- Androgen receptor activation and autocrine/paracrine androgen synthesis are potential mechanisms of recurrence of prostate cancer during ADT (CRPC). Thus, castrate levels of testosterone (<50 ng/dL) should be maintained by continuing LHRH agonist or antagonist while additional therapies are applied.
- Once the tumor becomes resistant to initial ADT, there are a variety of options that may afford clinical benefit. The available options are based on whether the patient has evidence of metastases by conventional imaging, M0 CRPC vs. M1 CRPC, and whether or not the patient is symptomatic.
- In the setting in which patients have no or minimal symptoms, administration of secondary hormonal therapy can include:
  - Second-generation antiandrogen
    - Apalutamide (for M0 and PSADT ≤10 mo)
    - Darolutamide (for M0 and PSADT ≤10 mo)
    - Enzalutamide (for M0 and PSADT ≤10 mo or M1)
  - Androgen metabolism inhibitor
    - Abiraterone + prednisone (for M1 only)
    - Abiraterone + methylprednisolone (for M1 only)
  - Other secondary hormone therapy (for M0 or M1)
    - Ketoconazole
    - Ketoconazole plus hydrocortisone
    - First-generation antiandrogen (nilutamide, flutamide, or bicalutamide)
    - Corticosteroids (hydrocortisone, prednisone, or dexamethasone)
    - DES or other estrogens
    - Antiandrogen withdrawal
- Abiraterone should be given with concurrent steroid, either prednisone 5 mg orally twice daily or methylprednisolone 4 mg orally twice daily, depending on the formulation of abiraterone used. Abiraterone with either steroid should not be given following progression on abiraterone with the other steroid.
- Abiraterone with prednisone can be administered at a dose of 250 mg/day following a low-fat breakfast, as an alternative to the dose of 1000 mg/day after an overnight fast. The cost savings from this dosing may reduce financial toxicity and improve compliance. Szmulewitz RZ, Peer CJ, Ibraheem A, et al. Prospective international randomized phase II study of low-dose abiraterone with food versus standard dose abiraterone In castration-resistant prostate cancer. J Clin Oncol 2018;36:1389-1395.
- Ketoconazole ± hydrocortisone should not be used if the disease progressed on abiraterone.
- DES has cardiovascular and thromboembolic side effects at any dose but frequency is dose and agent dependent. DES should be initiated at 1 mg/day and increased, if necessary, to achieve castrate levels of serum testosterone (<50 ng/dL). Other estrogens delivered topically or parenterally may have less frequent side effects but data are limited.
- A phase 3 study of patients with M0 CRPC and a PSADT ≤10 mo showed apalutamide (240 mg/day) improved the primary endpoint of metastasis-free survival over placebo (40.5 mo vs. 16.2 mo). No significant difference was seen in overall survival at the first interim analysis. Adverse events included rash (24% vs. 5.5%), fracture (11% vs. 6.5%), and hypothyroidism (8% vs. 2%). Bone support should be used in patients receiving apalutamide.
- A phase 3 study of patients with M0 CRPC and a PSADT ≤10 mo showed enzalutamide (160 mg/day) improved the primary endpoint of metastasis-

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Continued

## PRINCIPLES OF ANDROGEN DEPRIVATION THERAPY

free survival over placebo (36.6 mo vs. 14.7 mo). No significant difference was seen in overall survival at the first interim analysis. Adverse events included falls and nonpathologic fractures (17% vs. 8%), hypertension (12% vs. 5%), major adverse cardiovascular events (5% vs. 3%), and mental impairment disorders (5% vs. 2%). Bone support should be used in patients receiving enzalutamide.

- A phase 3 study of patients with M0 CRPC and a PSADT ≤10 mo showed darolutamide (600 mg twice daily) improved the primary endpoint of metastasis-free survival over placebo (40.4 mo vs. 18.4 mo). An improvement in overall survival was seen at the first interim analysis (HR for death, 0.71; 95% CI, 0.50-0.99; P = .045), although these data are immature (median survival was not reached in either arm). Adverse events that occurred more frequently in the treatment arm included fatigue (12.1% vs. 8.7%), pain in an extremity (5.8% vs. 3.2%), and rash (2.9% vs. 0.9%). The incidence of fractures was similar between darolutamide and placebo (4.2% vs. 3.6%).
- In a randomized controlled trial in the setting of M1 CRPC prior to docetaxel chemotherapy, abiraterone and low-dose prednisone (5 mg BID) compared to prednisone alone improved radiographic progression-free survival (rPFS), time to initiation of chemotherapy, time to onset or worsening of pain, and time to deterioration of performance status. An improvement in overall survival was demonstrated. Use of abiraterone and prednisone in this setting is a category 1 recommendation. The side effects of abiraterone that require ongoing monitoring include hypertension, hypokalemia, peripheral edema, atrial fibrillation, congestive heart failure, liver injury, and fatigue, as well as the known side effects of ADT and long-term corticosteroid use.
- A phase 3 study of docetaxel-naive men with M1 CRPC showed that enzalutamide (160 mg daily) resulted in significant improvement in rPFS and overall survival. The use of enzalutamide in this setting is category 1. The side effects of enzalutamide that require long-term monitoring include fatigue, diarrhea, hot flashes, headache, and seizures (reported in 0.9% of men on enzalutamide).
- For symptomatic patients with M1 CRPC, all secondary hormone options listed above are allowed, but initial use of docetaxel may be preferred. Both randomized trials of abiraterone and enzalutamide in the pre-docetaxel setting were conducted in men who had no or minimal symptoms due to M1 CRPC. How these agents compare to docetaxel for pain palliation in this population of patients is not clear. Both drugs have palliative effects in the post-docetaxel setting. Both abiraterone and enzalutamide are approved in this pre-docetaxel setting and have category 1 recommendations. Both drugs are suitable options for men who are not good candidates to receive docetaxel.
- In the post-docetaxel M1 CRPC population, enzalutamide and abiraterone plus prednisone have been shown to extend survival in randomized controlled trials. Therefore, each agent has a category 1 recommendation.
- Two randomized clinical trials (STRIVE and TERRAIN) showed that 160 mg/day enzalutamide improved PFS compared to 50 mg/day bicalutamide in men with treatment-naive M1 CRPC and, therefore, enzalutamide may be the preferred option in this setting. However, bicalutamide can still be considered in some patients, given the different side-effect profiles of the agents and the increased cost of enzalutamide.
- Evidence-based guidance on the sequencing of agents in either pre- or post-docetaxel remains unavailable.

### ADT for Patients on Observation Who Require Treatment

- Treatment for patients who progressed on observation of localized disease is LHRH agonist or antagonist (category 2B for LHRH antagonist) or orchietomy.

### Optimal ADT

- LHRH agonist or antagonist (medical castration) and bilateral orchiectomy (surgical castration) are equally effective.
- Combined androgen blockade (medical or surgical castration combined with an antiandrogen) provides modest to no benefit over castration alone in patients with metastatic disease.
- Antiandrogen therapy should precede or be coadministered with LHRH agonist and be continued in combination for at least 7 days for patients with overt metastases who are at risk of developing symptoms associated with the flare in testosterone with initial LHRH agonist alone.
- Antiandrogen monotherapy appears to be less effective than medical or surgical castration and is not recommended.
- No clinical data support the use of finasteride or dutasteride with combined androgen blockade.
- Patients who do not achieve adequate suppression of serum testosterone

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Continued

## PRINCIPLES OF ANDROGEN DEPRIVATION THERAPY

(less than 50 ng/dL) with medical or surgical castration can be considered for additional hormonal manipulations (with estrogen, antiandrogens, LHRH antagonists, or steroids), although the clinical benefit remains uncertain. The optimal level of serum testosterone to effect "castration" has yet to be determined.

Monitor/Surveillance

- ADT has a variety of adverse effects, including hot flashes, loss of libido, erectile dysfunction, shrinkage of penis and testicles, loss of muscle mass and strength, fatigue, depression, hair loss, osteoporosis, greater incidence of clinical fractures, obesity, insulin resistance, alterations in lipids, and greater risk for diabetes and cardiovascular disease. Patients and their medical providers should be advised about these risks prior to treatment.
- Screening and treatment for osteoporosis are advised according to guidelines for the general population from the National Osteoporosis Foundation (www.nof.org). The National Osteoporosis Foundation guidelines include recommendations for: 1) calcium (1000–1200 mg daily from food and supplements) and vitamin D3 (400–1000 IU daily); and 2) additional treatment for men aged ≥50 y with low bone mass (T-score between -1.0 and -2.5, osteopenia) at the femoral neck, total hip, or lumbar spine by DEXA and a 10-year probability of hip fracture ≥3% or a 10-year probability of a major osteoporosis-related fracture ≥20%. Fracture risk can be assessed using FRAX®, the algorithm released by WHO. ADT should be considered "secondary osteoporosis" when using the FRAX® algorithm. Treatment options to increase bone density, a surrogate for fracture risk in men without metastases, include denosumab (60 mg SQ every 6 mo), zoledronic acid (5 mg IV annually), and alendronate (70 mg PO weekly).
- A baseline DEXA scan should be obtained before starting therapy in men at increased risk for fracture based on FRAX® screening. A follow-up DEXA scan after 1 year of therapy is recommended by the International Society for Clinical Densitometry, although there is no consensus on the optimal approach to monitoring the effectiveness of drug therapy. Use of biochemical markers of bone turnover to monitor response to therapy is not recommended. The serum level of 25-hydroxy vitamin D and average daily dietary intake of vitamin D will assist the nutritionist in making a patient-specific recommendation for vitamin D supplementation. There are currently no guidelines on how often to monitor vitamin D levels. However, for those who require monitoring with DEXA scans, it makes sense to check the serum vitamin D level at the same time.
- Denosumab (60 mg SQ every 6 mo), zoledronic acid (5 mg IV annually), and alendronate (70 mg PO weekly) increase bone mineral density, a surrogate for fracture risk, during ADT for prostate cancer. Treatment with either denosumab, zoledronic acid, or alendronate sodium is recommended when the absolute fracture risk warrants drug therapy.
- Screening for and intervention to prevent/treat diabetes and cardiovascular disease are recommended in men receiving ADT. These medical conditions are common in older men and it remains uncertain whether strategies for screening, prevention, and treatment of diabetes and cardiovascular disease in men receiving ADT should differ from the general population.

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## PRINCIPLES OF IMMUNOTHERAPY AND CHEMOTHERAPY

### Systemic Therapy for M1 Castration-Naive Prostate Cancer

- Men with high-volume, ADT-naive, metastatic disease should be considered for ADT (See PROS-F) and docetaxel based on the results of the ECOG 3805 (CHAARTED) trial. In this study, 790 men were randomized to 6 cycles of docetaxel at 75 mg/m$^2$ every 3 weeks with dexamethasone with ADT vs. ADT alone. In the majority subset of patients with high-volume disease, defined as 4 or more bone metastases including one extra-axial bone lesion or visceral metastases, a 17-month improvement in overall survival was observed (HR, 0.60; *P* = .0006). Improvements in PSA response, time to clinical progression, and time to recurrence were observed with use of docetaxel. Toxicities of 6 cycles of docetaxel included fatigue, neuropathy, stomatitis, diarrhea, and neutropenia with or without fever. The use of myeloid growth factors should follow the NCCN Guidelines for Hematopoietic Growth Factors, based on risk of neutropenic fever. Docetaxel should not be offered to men without metastatic prostate cancer or to men with low-volume metastatic prostate cancer, since this subgroup was not shown to have improved survival in either the ECOG study or a similar European (GETUG-AFU 15) trial.

### Systemic Therapy for M1 CRPC

- Chemotherapy
  - Docetaxel with concurrent steroid
    - Concurrent steroids may include: dexamethasone on the day of chemotherapy or daily prednisone.
  - Cabazitaxel with concurrent steroid
    - Concurrent steroids may include: dexamethasone on the day of chemotherapy or daily prednisone.
- Every-3-week docetaxel with concurrent steroid is the preferred first-line chemotherapy treatment based on phase 3 clinical trial data for men with symptomatic mCRPC. Radium-223 has been studied in symptomatic patients who are not candidates for docetaxel-based regimens and resulted in improved overall survival. Abiraterone and enzalutamide have been shown to extend survival in patients who progressed on docetaxel. (See PROS-F). Mitoxantrone and prednisone may provide palliation but have not been shown to extend survival.
- Only regimens utilizing docetaxel on an every-3-week schedule demonstrated beneficial impact on survival. The duration of therapy should be based on the assessment of benefit and toxicities. In the pivotal trials establishing survival advantage of docetaxel-based chemotherapy, patients received up to 10 cycles of treatment if no progression and no prohibitive toxicities were noted.
- Patients who are not candidates for docetaxel or who are intolerant of docetaxel should be considered for cabazitaxel with concurrent steroid, based on recent results that suggest clinical activity of cabazitaxel in mCRPC. Cabazitaxel was associated with lower rates of peripheral neuropathy than docetaxel, particularly at 20 mg/m$^2$ (12% vs. 25%) and may be appropriate in patients with pre-existing mild peripheral neuropathy. Current data do not support greater efficacy of cabazitaxel over docetaxel.
- Rising PSA should not be used as the sole criteria for progression. Assessment of response should incorporate clinical and radiographic criteria.
- Cabazitaxel at 25 mg/m$^2$ with concurrent steroid has been shown in a randomized phase 3 study (TROPIC) to prolong overall survival, PFS, and PSA and radiologic responses when compared with mitoxantrone and prednisone and is FDA approved in the post-docetaxel second-line setting. Toxicity at this dose was significant and included febrile neutropenia, severe diarrhea, fatigue, nausea/vomiting, anemia, thrombocytopenia, sepsis, and renal failure. A recent trial, PROSELICA, compared cabazitaxel 25 mg/m$^2$ every 3 weeks to 20 mg/m$^2$ every 3 weeks. Cabazitaxel 20 mg/m$^2$ had less toxicity; febrile neutropenia, diarrhea, and fatigue were less frequent. Cabazitaxel at 20 mg/m$^2$ had a significantly lower PSA response rate but nonsignificantly lower radiographic response rate and non-significantly shorter PFS and overall survival (13.4 vs. 14.5 mo) compared to 25 mg/m$^2$. Cabazitaxel starting dose can be either 20 mg/m$^2$ or 25 mg/m$^2$ for men with mCRPC who have progressed despite prior docetaxel chemotherapy. Cabazitaxel 25 mg/m$^2$ with concurrent steroid may be considered for healthy men who wish to be more aggressive. Growth factor support may be needed with either dose.
- Docetaxel retreatment can be attempted in men who have not demonstrated definitive evidence of progression on prior docetaxel therapy.
- No chemotherapy regimen to date has demonstrated improved survival or quality of life after cabazitaxel, and trial participation should be encouraged.

Continued

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## PRINCIPLES OF IMMUNOTHERAPY AND CHEMOTHERAPY

- Treatment decisions around off-label chemotherapy use in the treatment-refractory CRPC should be individualized based on comorbidities and functional status and after informed consent.
- No benefits of combination approaches over sequential single-agent therapies have been demonstrated, and toxicity is higher with combination regimens.
- See NCCN Guidelines for Hematopoietic Growth Factors for recommendations on growth factor support.
- Immunotherapy
  - Men with asymptomatic or minimally symptomatic mCRPC may consider immunotherapy.
  - Sipuleucel-T
    - Sipuleucel-T is only for asymptomatic or minimally symptomatic, no liver metastases, life expectancy >6 mo, ECOG performance status 0-1.
    - Sipuleucel-T is not recommended for patients with small cell/neuroendocrine prostate cancer.
    - Sipuleucel-T has been shown in a phase 3 clinical trial to extend mean survival from 21.7 mo in the control arm to 25.8 mo in the treatment arm, which constitutes a 22% reduction in mortality risk.
    - Sipuleucel-T is well tolerated; common complications include chills, pyrexia, and headache.
  - Pembrolizumab (for MSI-H or dMMR)
    - Only as subsequent systemic therapy for patients who have progressed through at least one line of systemic therapy for M1 CRPC

<u>Prevention of Skeletal-Related Events</u>

- In men with CRPC who have bone metastases, denosumab and zoledronic acid have been shown to prevent disease-related skeletal complications, which include fracture, spinal cord compression, or the need for surgery or RT to bone.
- When compared to zoledronic acid, denosumab was shown to be superior in prevention of skeletal-related events.
- A phase 3 clinical trial that assessed a role for zoledronic acid in men beginning ADT for bone metastases was negative.
- Choice of agent may depend on underlying comorbidities, whether the patient has been treated with zoledronic acid previously, logistics, and/or cost considerations.
  - Denosumab (preferred) is given subcutaneously every 4 weeks. Although renal monitoring is not required, denosumab is not recommended in patients with creatinine clearance <30 mL/min. When creatinine clearance is <60 mL/min, the risk for severe hypocalcemia increases. Even in patients with normal renal function, hypocalcemia is seen twice as often with denosumab than zoledronic acid and all patients on denosumab should be treated with vitamin D and calcium with periodic monitoring of serum calcium levels.
  - Zoledronic acid is given intravenously every 3 to 4 weeks or every 12 weeks. The dose is based on the serum creatinine obtained just prior to each dose and must be adjusted for impaired renal function. Zoledronic acid is not recommended for creatinine clearance <30 mL/min.
- Osteonecrosis of the jaw is seen with both agents; risk is increased in patients who have tooth extractions, poor dental hygiene, or a dental appliance. Patients should be referred for dental evaluation before starting either zoledronic acid or denosumab. If invasive dental procedures are required, bone-targeted therapy should be withheld until the dentist indicates that the patient has healed completely from all dental procedure(s).
- The optimal duration of therapy for either denosumab or zoledronic acid remains uncertain.
- The toxicity profile of denosumab when denosumab is used in patients who have been treated with zoledronic acid remains uncertain.

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## American Joint Committee on Cancer (AJCC)
## TNM Staging System For Prostate Cancer (8th ed., 2017)
### *Table 1.* Definitions for T, N, M

### *Clinical T (cT)*

| **T** | **Primary Tumor** |
|---|---|
| **TX** | Primary tumor cannot be assessed |
| **T0** | No evidence of primary tumor |
| **T1** | Clinically inapparent tumor that is not palpable |
| T1a | Tumor incidental histologic finding in 5% or less of tissue resected |
| T1b | Tumor incidental histologic finding in more than 5% of tissue resected |
| T1c | Tumor identified by needle biopsy found in one or both sides, but not palpable |
| **T2** | Tumor is palpable and confined within prostate |
| T2a | Tumor involves one-half of one side or less |
| T2b | Tumor involves more than one-half of one side but not both sides |
| T2c | Tumor involves both sides |
| **T3** | Extraprostatic tumor that is not fixed or does not invade adjacent structures |
| T3a | Extraprostatic extension (unilateral or bilateral) |
| T3b | Tumor invades seminal vesicle(s) |
| **T4** | Tumor is fixed or invades adjacent structures other than seminal vesicles such as external sphincter, rectum, bladder, levator muscles, and/or pelvic wall. |

### *Pathological T (pT)*

| **T** | **Primary Tumor** |
|---|---|
| **T2** | Organ confined |
| **T3** | Extraprostatic extension |
| T3a | Extraprostatic extension (unilateral or bilateral) or microscopic invasion of bladder neck |
| T3b | Tumor invades seminal vesicle(s) |
| **T4** | Tumor is fixed or invades adjacent structures other than seminal vesicles such as external sphincter, rectum, bladder, levator muscles, and/or pelvic wall |

Note: There is no pathological T1 classification.

Note: Positive surgical margin should be indicated by an R1 descriptor, indicating residual microscopic disease.

| **N** | **Regional Lymph Nodes** |
|---|---|
| **NX** | Regional lymph nodes cannot be assessed |
| **N0** | No positive regional nodes |
| **N1** | Metastases in regional node(s) |

| **M** | **Distant Metastasis** |
|---|---|
| M0 | No distant metastasis |
| M1 | Distant metastasis |
| M1a | Nonregional lymph node(s) |
| M1b | Bone(s) |
| M1c | Other site(s) with or without bone disease |

Note: When more than one site of metastasis is present, the most advanced category is used. M1c is most advanced.

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*Table 2.* **AJCC Prognostic Groups**

| Group | T | N | M | PSA (ng/mL) | Grade Group |
|---|---|---|---|---|---|
| **Stage I** | cT1a-c | N0 | M0 | PSA <10 | 1 |
| | cT2a | N0 | M0 | PSA <10 | 1 |
| | pT2 | N0 | M0 | PSA <10 | 1 |
| **Stage IIA** | cT1a-c | N0 | M0 | PSA ≥10 <20 | 1 |
| | cT2a | N0 | M0 | PSA ≥10 <20 | 1 |
| | pT2 | N0 | M0 | PSA ≥10 <20 | 1 |
| | cT2b | N0 | M0 | PSA <20 | 1 |
| | cT2c | N0 | M0 | PSA <20 | 1 |
| **Stage IIB** | T1-2 | N0 | M0 | PSA <20 | 2 |
| **Stage IIC** | T1-2 | N0 | M0 | PSA <20 | 3 |
| | T1-2 | N0 | M0 | PSA <20 | 4 |
| **Stage IIIA** | T1-2 | N0 | M0 | PSA ≥20 | 1-4 |
| **Stage IIIB** | T3-4 | N0 | M0 | Any PSA | 1-4 |
| **Stage IIIC** | Any T | N0 | M0 | Any PSA | 5 |
| **Stage IVA** | Any T | N1 | M0 | Any PSA | Any |
| **Stage IVB** | Any T | Any N | M1 | Any PSA | Any |

Note: When either PSA or Grade Group is not available, grouping should be determined by T category and/or either PSA or Grade Group as available.

**Histopathologic Type**
This classification applies to adenocarcinomas and squamous carcinomas, but not to sarcoma or transitional cell (urothelial) carcinoma of the prostate. Adjectives used to describe histologic variants of adenocarcinomas of prostate include mucinous, signet ring cell, ductal, and neuroendocrine, including small cell carcinoma. There should be histologic confirmation of the disease.

**Definition of Histologic Grade Group (G)**
Recently, the Gleason system has been compressed into so-called Grade Groups.

| Grade Group | Gleason Score | Gleason Pattern |
|---|---|---|
| 1 | ≤6 | ≤3+3 |
| 2 | 7 | 3+4 |
| 3 | 7 | 4+3 |
| 4 | 8 | 4+4, 3+5, 5+3 |
| 5 | 9 or 10 | 4+5, 5+4, 5+5 |

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# Discussion

**NCCN Categories of Evidence and Consensus**

**Category 1:** Based upon high-level evidence, there is uniform NCCN consensus that the intervention is appropriate.

**Category 2A:** Based upon lower-level evidence, there is uniform NCCN consensus that the intervention is appropriate.

**Category 2B:** Based upon lower-level evidence, there is NCCN consensus that the intervention is appropriate.

**Category 3:** Based upon any level of evidence, there is major NCCN disagreement that the intervention is appropriate.

**All recommendations are category 2A unless otherwise indicated.**

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## Overview

An estimated 174,650 new cases of prostate cancer will be diagnosed in 2019, accounting for 20% of new cancer cases in men.[1] The age-adjusted death rates from prostate cancer have declined 51% from 1993 to 2016.[1] Researchers have estimated that prostate cancer will account for 9.8% of male cancer deaths in 2018.[1] Over the past several years, the incidence of prostate cancer has declined, likely in part as a result of decreased detection attributed to decreased rates of prostate-specific antigen (PSA) screening.[2-4] The decreasing and comparatively low death rate suggests that increased public awareness with earlier detection and treatment has affected mortality from this prevalent cancer.

Early detection can lead to overtreatment of prostate cancers that do not threaten life expectancy, which results in unnecessary side effects that impair quality of life (QOL) and increase health care expenditures. The U.S. Preventive Services Task Force (USPSTF) recommended against PSA testing in 2012.[5] The incidence of metastatic disease has increased.[4,6] The rate of prostate cancer mortality, which had been in decline for 2 decades, has stabilized.[4] Prostate cancer incidence and deaths have increased in the past few years for the first time in recent history, with prostate cancer deaths increasing from an estimated 26,730 in 2017 to 31,620 in 2019.[1,7] Increases in the incidence of metastases at presentation and prostate cancer deaths may be influenced by declines in the rates of prostate cancer early detection, biopsies, diagnosis of localized prostate cancers, and radical prostatectomy that followed the 2012 USPSTF recommendations.[8-18] The USPSTF released updated recommendations in 2018 that include individualized, informed decision-making regarding prostate cancer screening in men aged 55 to 69 years.[19] These updated recommendations may allow for a more balanced approach to prostate cancer early detection. Better use of PSA for early detection of potentially fatal prostate cancer (see the NCCN Guidelines for Prostate Cancer Early Detection, available at www.NCCN.org) should decrease the risk of overdetection and overtreatment AND preserve the decrease in prostate cancer mortality.

## Literature Search Criteria and Guidelines Update Methodology

An electronic search of the PubMed database was performed to obtain key literature in prostate cancer published since the previous Guidelines update, using the search term “prostate cancer,” prior to the update of this version of the NCCN Guidelines® for Prostate Cancer. The PubMed database was chosen because it remains the most widely used resource for medical literature and indexes peer-reviewed biomedical literature.[20]

The search results were narrowed by selecting studies in humans published in English. Results were confined to the following article types: Clinical Trial, Phase III; Clinical Trial, Phase IV; Guideline; Randomized Controlled Trial; Meta-Analysis; Systematic Reviews; and Validation Studies.

The PubMed search resulted in 383 citations and their potential relevance was examined. The data from key PubMed articles selected by the panel for review during the Guidelines update as well as articles from additional sources deemed as relevant to these Guidelines and discussed by the panel have been included in this version of the Discussion section (eg, e-publications ahead of print, meeting abstracts). Recommendations for which high-level evidence is lacking are based on the panel’s review of lower-level evidence and expert opinion.

The complete details of the Development and Update of the NCCN Guidelines are available at www.NCCN.org.

## Estimates of Life Expectancy

Estimates of life expectancy have emerged as a key determinant of primary treatment, particularly when considering active surveillance or observation. Life expectancy can be estimated for groups of men, but it is difficult to extrapolate these estimates to an individual patient. Life expectancy can be estimated using the Minnesota Metropolitan Life Insurance Tables, the Social Security Administration Life Insurance Tables,[21] or the WHO's Life Tables by Country,[22] and adjusted for individual patients by adding or subtracting 50% based on whether one believes the patient is in the healthiest quartile or the unhealthiest quartile, respectively.[23] As an example, the Social Security Administration Life Expectancy for a 65-year-old American man is 17.7 years. If judged to be in the upper quartile of health, a life expectancy of 26.5 years is assigned. If judged to be in the lower quartile of health, a life expectancy of 8.8 years is assigned. Thus, treatment recommendations could change dramatically using the NCCN Guidelines if a 65-year-old man was judged to be in either poor or excellent health.

## Prostate Cancer Genetics

Family history of prostate cancer raises the risk of prostate cancer.[24-26] In addition, prostate cancer has been associated with hereditary breast and ovarian cancer (HBOC) syndrome (due to germline mutations in homologous DNA repair genes) and Lynch syndrome (resulting from germline mutations in DNA mismatch repair genes).[27-31] In fact, approximately 11% of patients with prostate cancer and at least 1 additional primary cancer carry germline mutations associated with increased cancer risk.[32] Therefore, the panel recommends a thorough review of personal and family history for all patients with prostate cancer.

The newfound appreciation of the frequency of germline DNA repair gene mutations (discussed in more detail below) has implications for family genetic counseling, cancer risk syndromes, and assessment of personal risk for second cancers. Some patients with prostate cancer and their families may be at increased risk for breast and ovarian cancer, melanoma, and pancreatic cancer (HBOC); colorectal cancers (Lynch syndrome); and other cancer types. Data also suggest that patients with prostate cancer who have *BRCA1/2* germline mutations have increased risk of progression on local therapy and decreased overall survival (OS).[33-35] This information should be discussed with such men if they are considering active surveillance. Finally, there are possible treatment implications for patients with DNA repair defects (see *Treatment Implications for Patients with DNA Repair Gene Mutations*, below).

Prostate cancer is often associated with somatic mutations that occur in the tumor but not in the germline. An estimated 89% of metastatic castration-resistant prostate cancer (CRPC) tumors contain a potentially actionable mutation, with only about 9% of these occurring in the germline.[36] Both germline and tumor mutations are discussed herein.

### Homologous DNA Repair Genes

Somatic mutations in DNA repair pathway genes occur in a reported 19% of localized prostate tumors and 23% of metastatic CRPC tumors, with most mutations found in *BRCA2* and *ATM*.[36,37] These tumor mutations are often associated with germline mutations. For example, 42% of patients with metastatic CRPC and somatic mutations in *BRCA2* were found to carry the mutation in their germlines.[36] In localized prostate cancer, that number was 60%.[37] In fact, recent data indicate that 11.8% of men with metastatic prostate cancer have germline mutations in 1 of 16 DNA repair genes: *BRCA2* (5.3%), *ATM* (1.6%), *CHEK2* (1.9%), *BRCA1* (0.9%), *RAD51D* (0.4%), *PALB2* (0.4%), *ATR* (0.3%), and *NBN*, *PMS2*, *GEN1*, *MSH2*, *MSH6*, *RAD51C*, *MRE11A*, *BRIP1*, or *FAM175A*.[38] In patients with localized prostate cancer in the TCGA cohort,[37] the rates of germline DNA repair mutations were 6% in those with high-risk prostate cancer and 2% in low/intermediate risk.[38] In another study, 16% of unselected patients with metastatic CRPC harbored germline mutations in *BRCA2, ATM*, and *BRCA1*.[39]

An additional study showed that 9 of 125 men with high-risk, very-high-risk, or metastatic prostate cancer (7.2%) had pathogenic germline mutations in *MUTYH* (4), *ATM* (2), *BRCA1* (1), *BRCA2* (1), and *BRIP1* (1).[40] In this study, the rate of mutation identification in men with metastatic disease was 28.6% (2 of 7 men). Although having a relative with breast cancer was associated with germline mutation identification ($P$ = .035), only 45.5% of the mutation carriers in the study had mutations that were concordant with their personal and family history. Another study also found that a family history of breast cancer increased the chances of identifying a germline DNA repair gene mutation in men with prostate cancer (OR, 1.89; 95% CI, 1.33–2.68; $P$ = .003).[41] In a study of an unselected cohort of 3607 patients with a personal history of prostate cancer who had germline genetic testing based on clinician referral, 11.5% had germline mutations in *BRCA2*, *CHEK2*, *ATM*, *BRCA1*, or *PALB2*.[42]

More than 2% of Ashkenazi Jews carry germline mutations in *BRCA1* or *BRCA2*, and these carriers have a 16% chance (95% CI, 4%–30%) of developing prostate cancer by the age of 70.[43] In a study of 251 unselected Ashkenazi Jewish patients with prostate cancer, 5.2% had germline mutations in *BRCA1* and *BRCA2*, compared with 1.9% of control Ashkenazi Jewish men.[44]

Germline *BRCA1* or *BRCA2* mutations have been associated with an increased risk for prostate cancer in numerous reports.[30,31,44-54] In particular, *BRCA2* mutations have been associated with a 2- to 6-fold increase in the risk for prostate cancer, whereas the association of *BRCA1* mutations and increased risks for prostate cancer are less consistent.[30,31,44,46,48,53] In addition, limited data suggest that germline mutations in *ATM, PALB2,* and *CHEK2* increase the risk of prostate cancer.[55-58] Furthermore, prostate cancer in men with germline *BRCA* mutations appears to occur earlier, has a more aggressive phenotype, and is associated with significantly reduced survival times than in non-carrier patients.[34,35,59-62]

### DNA Mismatch Repair Genes

Tumor mutations in *MLH1*, *MSH2*, *MSH6*, and *PMS2* may result in tumor microsatellite instability (MSI) and deficient mismatch repair (dMMR; detected by immunohistochemistry) and are sometimes associated with germline mutations and Lynch syndrome. In a study of >15,000 patients with cancer treated at Memorial Sloan Kettering Cancer Center who had their tumor and matched normal DNA sequenced and tumor MSI status assessed, approximately 5% of 1048 patients with prostate cancer had MSI-high (MSI-H) or MSI-indeterminate tumors, 5.6% of whom were found to have Lynch syndrome (0.29% of patients with prostate cancer).[27] In another prospective case series, the tumors of 3.1% of 1033 patients with prostate cancer demonstrated MSI-H/dMMR status, and 21.9% of these patients had Lynch syndrome (0.68% of the total population).[63] In a study of an unselected cohort of 3607 patients with a personal history of prostate cancer who had germline genetic testing based on clinician referral, 1.7% had germline mutations in *PMS2*, *MLH1, MSH2,* or *MSH6*.[42]

### Effect of Intraductal or Ductal Histology

Ductal prostate carcinomas are rare, accounting for approximately 1.3% of prostate carcinomas.[64] Intraductal prostate cancer may be more common, especially in higher risk groups.[65] It is important to note that there is significant overlap in diagnostic criteria and that intraductal, ductal, and invasive cribriform features may coexist in the same biopsy. By definition, intraductal carcinoma includes cribriform proliferation of malignant cells as long as they remain confined to a preexisting gland that is surrounded by basal cells. These features are seen frequently with an adjacent invasive cribriform component and would be missed without the use of basal cell markers.

Limited data suggest that prostate tumors with ductal or intraductal histology have increased genomic instability.[66-68] In particular, tumors with these histologies may be more likely to harbor somatic and/or germline MMR gene alterations than those with adenocarcinoma histology.[69,70] In addition, limited data suggest that germline homologous DNA repair gene mutations may be more common in prostate tumors of ductal or intraductal origin[71,72] and that intraductal histology is common in germline *BRCA2* mutation carriers with prostate cancer.[73] Overall, the panel believes that the data connecting histology and the presence of genomic alterations are stronger for intraductal than ductal histology at this time. Therefore, patients with presence of intraductal carcinoma on biopsy should have germline testing as described below.

## Genetic Testing Recommendations

### *Germline Testing Based on Family History, Histology, and Risk Groups*

The panel recommends inquiring about family and personal history of cancer at time of initial diagnosis. Based on the data discussed above, the panel recommends *germline* genetic testing, with or without pre-test genetic counseling, for patients with prostate cancer and any of the following:

- A positive family history (see definition in the guidelines above)
- High-risk, very-high-risk, regional, or metastatic prostate cancer, regardless of family history
- Ashkenazi Jewish ancestry
- Intraductal histology

Germline testing, when performed, should include *MLH1, MSH2, MSH6*, and *PMS2* (for Lynch syndrome) and the homologous recombination *genes BRCA2, BRCA1, ATM, PALB2,* and *CHEK2*. Cancer predisposition next-generation sequencing (NGS) panel testing, at a minimum including *BRCA2, BRCA1, ATM, CHEK2, PALB2, MLH1, MSH2, MSH6,* and *PMS2*, can be considered. Additional genes may be appropriate depending on clinical context. For example, *HOXB13* is a prostate cancer risk gene and, whereas there are not currently clear therapeutic implications in the advanced disease setting, testing may be valuable for family counseling.[74,75]

### *Somatic Tumor Testing Based on Risk Groups*

*Tumor* testing recommendations are as follows:

1. Tumor testing for somatic homologous recombination gene mutations (eg, *BRCA1, BRCA2, ATM, PALB2, FANCA, RAD51D*, *CHEK2*) can be considered in patients with regional or metastatic prostate cancer.
2. Tumor testing for MSI or dMMR can be considered in patients with regional or metastatic prostate cancer.
3. Multigene molecular testing can be considered for patients with low and favorable-intermediate-risk prostate cancer and life expectancy ≥10 years (see *Tumor Multigene Molecular Testing*, below).
4. The Decipher molecular assay can be considered as part of counseling for risk stratification in patients with PSA resistance/recurrence after radical prostatectomy (category 2B; see *Tumor Multigene Molecular Testing*, below).

If mutations in *BRCA2, BRCA1, ATM, CHEK2,* or *PALB2* are found, the patient should be referred for genetic counseling to assess for the possibility of HBOC.

If MSI testing is performed, testing using an NGS assay validated for prostate cancer is preferred.[76-78] If MSI-H or dMMR is found, the patient should be referred for genetic counseling to assess for the possibility of Lynch syndrome. MSI-H or dMMR indicate eligibility for pembrolizumab in second and subsequent lines of treatment for CRPC (see *Pembrolizumab*, below).

Patients should be informed that somatic tumor sequencing has the potential to uncover germline findings. However, virtually none of the NGS tests is designed or validated for germline assessment. Therefore, over-interpretation of germline findings should be avoided. If a germline mutation is suspected, the patient should be recommended for genetic counseling and follow-up dedicated germline testing.

***Additional Testing***

Tumors from a majority of patients with metastatic CRPC harbor mutations in genes involved in the androgen receptor signaling pathway.[36] AR-V7 testing in circulating tumor cells (CTCs) can be considered to help guide selection of therapy in the post-abiraterone/enzalutamide metastatic CRPC setting (discussed in more detail below, under *Progression After Enzalutamide or Abiraterone*).

## Risk Stratification for Clinically Localized Disease

Optimal treatment of prostate cancer requires assessment of risk: How likely is a given cancer to be confined to the prostate or spread to the regional lymph nodes? How likely is the cancer to progress or metastasize after treatment? How likely is adjuvant or salvage radiation to control cancer after an unsuccessful radical prostatectomy? Prostate cancers are best characterized by a digital rectal exam (DRE) and radiographically determined clinical T stage, Gleason score and extent of cancer in the biopsy specimen, and serum PSA level. Imaging studies (ie, ultrasound, MRI) have been investigated intensively but have yet to be accepted as essential adjuncts to staging.

The NCCN Guidelines have, for many years, incorporated a risk stratification scheme that uses a minimum of stage, Gleason grade, and PSA to assign patients to risk groups. These risk groups are used to select the appropriate options that should be considered and to predict the probability of biochemical recurrence after definitive local therapy.[79] Risk group stratification has been published widely and validated, and provides a better basis for treatment recommendations than clinical stage alone.[80,81]

A new prostate cancer grading system was developed during the 2014 International Society of Urological Pathology (ISUP) Consensus Conference.[82] Several changes were made to the assignment of Gleason pattern based on pathology. The new system assigns Grade Groups from 1 to 5, derived from the Gleason score.

- Grade Group 1: Gleason score ≤6; only individual discrete well-formed glands
- Grade Group 2: Gleason score 3+4=7; predominantly well-formed glands with lesser component of poorly formed/fused/cribriform glands
- Grade Group 3: Gleason score 4+3=7; predominantly poorly formed/fused/cribriform glands with lesser component of well-formed glands
    - For cases with >95% poorly formed/fused/cribriform glands or lack of glands on a core or at radical prostatectomy, the component of <5% well-formed glands is not factored into the grade.
- Grade Group 4: Gleason score 4+4=8; 3+5=8; 5+3=8
    - Only poorly formed/fused/cribriform glands; or
    - Predominantly well-formed glands and lesser component lacking glands (poorly formed/fused/cribriform glands can be a more minor component); or
    - Predominantly lacking glands and lesser component of well-formed glands (poorly formed/fused/cribriform glands can be a more minor component)
- Grade Group 5: Gleason score 9-10; lack gland formation (or with necrosis) with or without poorly formed/fused/cribriform glands
    - For cases with >95% poorly formed/fused/cribriform glands or lack of glands on a core or at radical prostatectomy, the

component of <5% well-formed glands is not factored into the grade.

Many experts believe that ISUP Grade Groups will enable patients to better understand their true risk level and thereby limit overtreatment. The new Grade Group system was validated in 2 separate cohorts, one of >26,000 men and one of 5880 men, treated for prostate cancer with either radical prostatectomy or radiation.[83,84] Both studies found that Grade Groups predicted the risk of recurrence after primary treatment. For instance, in the larger study, the 5-year biochemical recurrence-free progression probabilities after radical prostatectomy for Grade Groups 1 through 5 were 96% (95% CI, 95–96), 88% (95% CI, 85–89), 63% (95% CI, 61–65), 48% (95% CI, 44–52), and 26% (95% CI, 23–30), respectively. The separation between Grade Groups was less pronounced in the radiation therapy (RT) cohort, likely because of increased use of neoadjuvant/concurrent/adjuvant androgen deprivation therapy (ADT) in the higher risk groups. In another study of the new ISUP Grade Group system, all-cause mortality and prostate cancer-specific mortality were higher in men in Grade Group 5 than in those in Grade Group 4.[85] Additional studies have supported the validity of this new system.[86-90] The NCCN Panel has accepted the new Grade Group system to inform better treatment discussions compared to those using Gleason score. Patients remain divided into very-low-, low-, intermediate-, high-, and very-high-risk groups.

The NCCN Guidelines Panel recognized that heterogeneity exists within each risk group. For example, an analysis of 12,821 patients showed that men assigned to the intermediate-risk group by clinical stage (T2b–T2c) had a lower risk of recurrence than men categorized according to Gleason score (7) or PSA level (10–20 ng/mL).[91] A similar trend of superior recurrence-free survival was observed in men placed in the high-risk group by clinical stage (T3a) compared to those assigned by Gleason score (8–10) or PSA level (>20 ng/mL), although it did not reach statistical significance. Other studies have reported differences in outcomes in the high-risk group depending on risk factors or primary Gleason pattern.[92,93] Evidence also shows heterogeneity in the low-risk group, with PSA levels and percent positive cores affecting pathologic findings after radical prostatectomy.[94,95]

In a retrospective study, 1024 patients with intermediate-risk prostate cancer were treated with radiation with or without neoadjuvant and concurrent ADT.[96] Multivariate analysis revealed that primary Gleason pattern 4, number of positive biopsy cores ≥50%, and presence of >1 intermediate-risk factors (IRFs; ie, T2b-c, PSA 10–20 ng/mL, Gleason score 7) were significant predictors of increased incidence of distant metastasis. The authors used these factors to separate the patients into unfavorable and favorable intermediate-risk groups and determined that the unfavorable intermediate-risk group had worse PSA recurrence-free survival and higher rates of distant metastasis and prostate cancer-specific mortality than the favorable intermediate-risk group. The use of active surveillance in men with favorable intermediate-risk prostate cancer is discussed below (see *Favorable Intermediate Risk*).

### Nomograms

The more clinically relevant information that is used in the calculation of time to PSA recurrence, the more accurate the result. A nomogram is a predictive instrument that takes a set of input data (variables) and makes predictions about an outcome. Nomograms predict more accurately for the individual patient than risk groups, because they combine the relevant prognostic variables. The Partin tables were the first to achieve widespread use for counseling men with clinically localized prostate cancer.[97-100] The tables give the probability (95% CIs) that a patient with a certain clinical stage, Gleason score, and PSA will have a cancer of each pathologic stage. Nomograms can be used to inform treatment decision-making for men contemplating active surveillance,[101-103] radical prostatectomy,[104-107] neurovascular bundle preservation[108-110] or omission of pelvic lymph node dissection (PLND) during radical prostatectomy,[111-114] brachytherapy,[104,115-117] or external beam RT (EBRT).[104,118] Biochemical progression-free survival can be reassessed postoperatively using age, diagnostic serum PSA, and pathologic grade and stage.[104,119-121] Potential success of adjuvant or salvage RT after unsuccessful radical prostatectomy can be assessed using a nomogram.[104,122]

None of the current models predicts with perfect accuracy, and only some of these models predict metastasis[103,104,119,123,124] and cancer-specific death.[105,107,125-127] Given the competing causes of mortality, many men who sustain PSA recurrence will not live long enough to develop clinical evidence of distant metastases or to die from prostate cancer. Those with a short PSA doubling time (PSADT) are at greatest risk of death. Not all PSA recurrences are clinically relevant; thus, PSADT may be a more useful measure of risk of death.[128] The NCCN Guidelines Panel recommends that NCCN risk groups be used to begin the discussion of options for the treatment of clinically localized prostate cancer and that nomograms be used to provide additional and more individualized information.

### Tumor Multigene Molecular Testing

Personalized or precision medicine is a goal for many translational and clinical investigators. The National Academy of Medicine has described several lessons that should accelerate the development of useful biomarkers[129] to inform men and their physicians about proper choices for treatment of clinically localized prostate cancer. Dr. Hayes has warned that a “bad tumor marker is as bad as a bad drug.”[130,131] The NCCN Prostate Cancer Guidelines Panel strongly advocates for use of life expectancy estimation, use of nomograms, and active surveillance as the only option for men with low-risk prostate cancer and life expectancy less than 10 years or very-low-risk prostate cancer and life expectancy less than 20 years. Although risk groups, life expectancy estimates, and nomograms help inform decisions, uncertainty about the risk of disease progression persists. American men continue to under-select active surveillance and their physicians may under-recommend it, likely as a result of this uncertainty.[132] In 2013, <20% of men with low-risk prostate cancer were managed with active surveillance.[16] However, active surveillance has become more common in some areas, such as Michigan, where its frequency has been measured and educational efforts have begun.[133,134]

Several tissue-based molecular assays have been developed in an effort to improve decision-making in newly diagnosed men considering active surveillance and in treated men considering adjuvant therapy or treatment for recurrence. Uncertainty about the risk of disease progression can be reduced if such molecular assays can provide accurate and reproducible prognostic or predictive information beyond NCCN risk group assignment and currently available life expectancy tables and nomograms. Retrospective case cohort studies have shown that these assays provide prognostic information independent of NCCN or CAPRA risk groups, which include likelihood of death with conservative management, likelihood of biochemical recurrence after radical prostatectomy or EBRT, likelihood of adverse pathologic features after radical prostatectomy, and likelihood of developing metastasis after operation or salvage EBRT.[135-144] A prospective, clinical utility study of 3966 patients newly diagnosed with localized prostate cancer found that the rates of active surveillance increased with use of a tissue-based gene expression classifier.[145] Active surveillance rates were 46.2%, 75.9%, and 57.9% for those whose classifier results were above the specified threshold, below the threshold, and those who did not undergo genomic testing, respectively ($P < .001$). The authors estimate that 1 additional patient may chose active surveillance for every 9 men with favorable risk prostate cancer who undergo genomic testing.

No randomized controlled trials have studied the utility of these tests. Several of these assays are available, and 4 have received positive reviews by the Molecular Diagnostic Services Program (MolDX) and are likely to be covered by CMS (Centers for Medicare & Medicaid Services). Several other tests are under development, and the use of these assays is likely to increase in the coming years.

Table 1 lists these tests in alphabetical order and provides an overview of each test, populations where each test independently predicts outcome, and supporting references. These molecular biomarker tests have been developed with extensive industry support, guidance, and involvement, and have been marketed under the less rigorous FDA regulatory pathway for biomarkers. Although full assessment of their clinical utility requires prospective randomized clinical trials, which are unlikely to be done, the panel believes that men with low or favorable intermediate disease may consider the use of Decipher, Oncotype DX Prostate, Prolaris, or ProMark during initial risk stratification. In addition, Decipher may be considered during workup for radical prostatectomy PSA persistence or recurrence (category 2B). Future comparative effectiveness research may allow these tests and others like them to gain additional evidence regarding their utility for better risk stratification of men with prostate cancer.

## Imaging

Imaging techniques are useful for staging and for detecting metastases and tumor recurrence. Anatomic imaging techniques include radiographs, ultrasound, CT, and MRI. Functional techniques include radionuclide bone scan (conventional Tc EDTMP scan), PET/CT, PET/MRI, and advanced MRI, such as spectroscopy and diffusion-weighted imaging (DWI). More details on each technique are outlined in the algorithm under *Principles of Imaging*.

The guidelines recommend pelvic +/- abdominal CT or MRI imaging as part of staging workup for men with longer life expectancies and favorable intermediate or higher risk disease if nomogram-predicted probability of lymph node involvement >10%. Multivariate analysis of retrospective data on 643 men with newly diagnosed prostate cancer who underwent staging CT found that PSA, Gleason score, and clinical T stage were associated independently with a positive finding ($P < .05$ for all).[146] A validation of NCCN's pelvic imaging recommendations using the SEER database found that only 0.3% to 0.4% of patients with positive lymph nodes are missed, depending on which nomogram is used, whereas the negative predictive value (NPV) was 99.5%.[147]

Bone imaging is recommended as part of staging for patients with longer life expectancies and higher Gleason grade, higher T stage, or higher PSA values as delineated in the algorithm. Conventional bone scan is recommended first, with subsequent plain films, CT, MRI, or F-18 sodium fluoride PET/CT or PET/MRI, C-11 choline PET/CT or PET/MRI, or F-18 fluciclovine PET/CT or PET/MRI (see *Nuclear Imaging*, below) to address equivocal findings. Retrospective evidence suggests that Gleason score and PSA levels are associated with positive bone scan findings.[148] The SEER database validation of NCCN's imaging recommendations found that only 0.14% of patients with bone metastases would have been missed, whereas the NPV was 99.8%.[147]

Transrectal ultrasonography (TRUS) is the most common technique for anatomic visualization of the prostate. TRUS is used to guide transrectal biopsies, and can be considered for patients with biochemical recurrence after operation or radiation.

The utility of imaging for men with an early biochemical recurrence after radical prostatectomy depends on disease risk before operation and pathologic stage, Gleason grade, PSA, and PSADT after recurrence. Patients with low- and intermediate-risk disease and low postoperative serum PSA levels have a very low risk of positive bone scans or CT scans.[149,150] In a series of 414 bone scans performed in 230 men with biochemical recurrence after radical prostatectomy, the rate of a positive bone scan for men with PSA >10 ng/mL was only 4%.[151] Serial PSA measurements can be helpful for stratifying men at highest risk of progression and metastases. Some men have detectable PSA after radical prostatectomy due to benign prostate tissue in the prostate fossa. They have low stable PSAs and a very low risk of prostate cancer progression.[152,153]

## Multiparametric MRI

The use of multiparametric MRI (mpMRI) in the staging and characterization of prostate cancer has increased in the last few years. To be considered “multiparametric,” MRI images must be acquired with at least one more sequence apart from the anatomical T2-weighted one, such as DWIs or dynamic contrast-enhanced (DCE) images. Furthermore, a high-quality mpMRI requires a 3.0 T magnet; the need for an endorectal coil remains controversial.

Evidence supports the implementation of mpMRI in several aspects of prostate cancer management. First, mpMRI helps detect large and poorly differentiated cancers (ie, Grade Group ≥2).[154] mpMRI has been incorporated into MRI-TRUS fusion-targeted biopsy protocols, which has led to an increase in the diagnosis of high-grade cancers with fewer biopsy cores, while reducing detection of low-grade and insignificant cancers.[155-157] Second, mpMRI aids in the detection of extracapsular extension (T staging), with high NPVs in low-risk men.[158] mpMRI results may inform decision-making regarding nerve-sparing operation.[159] Third, mpMRI has been shown to be equivalent to CT scan for staging of pelvic lymph nodes.[160,161] Finally, mpMRI out-performs bone scan and targeted x-rays for detection of bone metastases, with a sensitivity of 98% to 100% and specificity of 98% to 100% (vs. sensitivity of 86% and specificity of 98%–100% for bone scan plus targeted x-rays).[162]

## Nuclear Imaging

The use of PET/CT or PET/MRI imaging using tracers other than F-18 fluorodeoxyglucose (FDG) for staging of small-volume recurrent or metastatic prostate cancer is a rapidly developing field wherein most of the data are derived from single-institution series or registry studies. High variability among equipment, protocols, interpretation, and institutions provides challenges for application and interpretation of the utility of PET/CT or PET/MRI. Furthermore, FDA clearance and reimbursement for some tests makes unlikely the conduct of clinical trials to evaluate their utility and impact upon oncologic outcome. Three PET tracers are FDA cleared for use in men with prostate cancer: C-11 choline, F-18 sodium fluoride, and F-18 fluciclovine.

C-11 choline PET/CT or PET/MRI and F-18 fluciclovine PET/CT or PET/MRI detect small-volume disease in bone and soft tissues.[163,164] The reported sensitivity and specificity of C-11 choline PET/CT in restaging patients with biochemical recurrence ranges from 32% to 93% and from 40% to 93%, respectively.[165-174] The reported sensitivity and specificity of F-18 fluciclovine PET/CT ranges from 37% to 90% and from 40% to 100%, respectively.[171,175,176] A prospective study compared F-18 fluciclovine and C-11 choline PET/CT scans in 89 patients, and agreement was 85%.[171] The panel believes that F-18 fluciclovine PET/CT or PET/MRI or C-11 choline PET/CT or PET/MRI may be used in men with biochemical recurrence after primary treatment for further soft tissue and/or bone evaluation after bone scan, chest CT, and abdominal/pelvic CT or abdominal/pelvic MRI.

F-18 sodium fluoride PET/CT detects bone metastases with greater sensitivity, but less specificity, than standard bone scan imaging, reportedly in the range of 87% to 100% and 62% to 89%, respectively.[177-180] F-18 sodium fluoride PET/CT was evaluated in men with biochemical relapse after prior local therapy.[181] The positive detection rate of bone metastases not seen on CT and bone scan was 16.2%.

The panel believes that F-18 sodium fluoride, C-11 choline, and F-18 fluciclovine PET/CT or PET/MRI may be considered after bone scan for further evaluation of the bones when bone scan results are equivocal. A typical application is to resolve uncertainty when bone scan reveals a single lesion and suspicion for diffuse metastases is high. The panel cautions, however, that earlier detection of bone metastatic disease may result in earlier use of newer and more expensive therapies, which may not improve oncologic outcome or OS.

Newer tracers are under development, but they are neither FDA cleared nor readily available and are considered investigational at this time. For instance, gallium-68 prostate-specific membrane antigen (PSMA) may provide better detection of recurrences at lower PSA levels than reported for FDA-approved imaging agents, and has comparable sensitivity (76%–86%) and specificity (86%–100%).[182-185] Another investigational agent, F-18 fluorodihydrotestosterone (FDHT), targets the androgen receptor and is not effective in the castration-naïve setting, but shows promise in CRPC, with sensitivity in the range of 63% to 97%.[186,187] C-11 acetate relies upon increased levels of fatty acid synthetase reported in prostate cancer. C-11 acetate performs similarly to C-11 choline but may have better specificity, except high-quality data remain unavailable.[188]

The panel notes that false-positive rates are high; therefore, histologic confirmation is strongly recommended whenever feasible. Moreover, these PET/CT and PET/MRI tests are expensive, and, whereas results may change treatment,[189] they may not change oncologic outcome. Earlier detection of bone metastatic disease, for instance, may result in earlier use of newer and more expensive therapies, which may not improve oncologic outcome or OS. The Panel remains unsure of how to treat patients when M1 is suggested by PET-based imaging but not by conventional imaging.

Table 2 summarizes the main PET imaging tracers studied in prostate cancer. F-18 FDG PET should not be used routinely, because data are limited in patients with prostate cancer and suggest that its sensitivity is significantly lower than that seen with other tracers.[181,190,191]

### Risks of Imaging

As with any medical procedure, imaging is not without risk. Some of these risks are concrete and tangible, while others are less clear. Risks associated with imaging include exposure to ionizing radiation, adverse reaction to contrast media, false-positive scans, and overdetection.

Deterministic and stochastic are two types of effects from exposure to ionizing radiation by x-ray, CT, or PET/CT. Deterministic effects are those that occur at a certain dose level, and include events such as cataracts and radiation burns. No effect is seen below the dose threshold. Medical imaging is always performed almost below the threshold for deterministic effects. Stochastic effects tend to occur late, increase in likelihood as dose increases, and have no known lower “safe” limit. The major stochastic effect of concern in medical imaging is radiation-induced malignancy. Unfortunately, no direct measurements are available to determine risk of cancer arising from one or more medical imaging events, so risks are calculated using other models (such as from atomic bomb survivors). The literature is conflicting with regard to the precise risk of secondary malignancies in patients undergoing medical imaging procedures. There is a small but finite risk of developing secondary malignancies as a result of medical imaging procedures, and the risk is greatest in young patients.

However, the absolute risk of fatal malignancy arising from a medical imaging procedure is very low, and is difficult to detect given the prevalence of cancer in the population and the multiple factors that contribute to oncogenesis.[192] Efforts should be made to minimize dose from these procedures, which begin with judicious use of imaging only when justified by the clinical situation. Harm may arise from not imaging a patient, through disease non-detection, or from erroneous staging.

Many imaging studies make use of contrast material delivered by oral, intravenous, or rectal routes. The use of contrast material may improve study performance, but reactions to contrast material may occur and they should be used only when warranted. Some patients develop adverse reactions to iodinated intravenous contrast material. Most reactions are mild cutaneous reactions (eg, hives, itching) but occasionally severe reactions can be life-threatening (bronchospasm or anaphylactoid). The risk of severe reaction is low with non-ionic contrast materials and may be about 1:170,000 injections.[193] Both iodinated CT contrast material and gadolinium-based MR contrast materials can affect renal function, particularly when renal function is impaired. MR contrast materials also have been associated with systemic nephrogenic sclerosis in patients with impaired renal function. Centers performing imaging studies with contrast materials should have policies in place to address the use of contrast in these patients.

Every imaging test has limitations for sensitivity, specificity, and accuracy, which are modulated further by the expertise of the interpreting physician. Harm can arise from failure to detect a tumor or tumor recurrence (ie, false negative), but harm to the patient and added expense to the medical system also can result from false-positive scans. Improper interpretation of a benign finding as malignant can lead to significant patient anxiety, additional and unnecessary imaging, and invasive procedures that carry their own risks for adverse outcomes.

Accurate and medically relevant interpretation of imaging studies requires familiarity and expertise in the imaging modality, attention to detail in image review, knowledge of tumor biology, and familiarity with treatment options and algorithms. Challenging cases are best addressed through direct communication, either physician-to-physician or in a multidisciplinary tumor board setting.

Medical imaging is a critical tool in the evaluation and management of patients with malignancy. However, as with any medical procedure, imaging is not without risks to patients. Inappropriate use of imaging also has been identified as a significant contributor to health care costs in the United States and worldwide. Therefore, imaging should be performed only when medically appropriate, and in a manner that reduces risk (eg, minimizing radiation dose). An algorithmic approach to the use of imaging, such as by NCCN and the Appropriateness Criteria developed by the American College of Radiology,[194] can assist in medical decision-making.

## Observation

Observation involves monitoring the course of prostate cancer with the expectation to deliver palliative therapy for development of symptoms or change in exam or PSA that suggests symptoms are imminent. Observation thus differs from active surveillance. The goal of observation is to maintain QOL by avoiding noncurative treatment when prostate cancer is unlikely to cause mortality or significant morbidity. The main advantage of observation is avoidance of possible side effects of unnecessary definitive therapy or ADT. However, patients may develop urinary retention or pathologic fracture without prior symptoms or increasing PSA level.

Observation is applicable to elderly or frail men with comorbidity that will likely out-compete prostate cancer for cause of death. Johansson and colleagues[195] observed that only 13% of men developed metastases 15 years after diagnosis of T0-T2 disease and only 11% had died from prostate cancer. Because prostate cancer will not be treated for cure for patients with shorter life expectancies, observation for as long as possible is a reasonable option based on physician discretion. Monitoring should include PSA and physical exam no more often than every 6 months, but will not involve surveillance biopsies or radiographic imaging. When symptoms develop or are imminent, patients can begin palliative ADT.

## Active Surveillance

Active surveillance (formerly referred to as watchful waiting, expectant management, or deferred treatment) involves actively monitoring the course of the disease with the expectation to deliver curative therapy if the cancer progresses. Unlike observation, active surveillance is mainly applicable to younger men with seemingly indolent cancer with the goal to defer treatment and its potential side effects. Because these patients have a longer life expectancy, they should be followed closely and treatment should start promptly should the cancer progress so as not to miss the chance for cure.

In one study, approximately two thirds of eligible men avoided treatment, and thus the possible associated side effects of treatment, after 5 years of active surveillance.[196] In another study, 55% of the population remained untreated at 15 years.[197] Although a proportion of men on active surveillance will eventually undergo treatment, the delay does not appear to impact cure rates, and several studies have shown that active surveillance is safe.[196-200] In fact, a 2015 meta-analysis of 26 active surveillance cohort studies that included 7627 men identified only 8 prostate cancer deaths and 5 cases of metastasis.[201] Further, the ProtecT study, which randomized 1643 men with localized prostate cancer to active surveillance, radical prostatectomy, or RT, found no significant difference in the primary outcome of prostate cancer mortality at a median of 10 years follow-up.[202] Of 17 prostate cancer deaths (1% of study participants), 8 were in the active surveillance group, 5 were in the operation group, and 4 were in the radiation group ($P = .48$ for the overall comparison). However, higher rates of disease progression and metastases were seen in the active surveillance group. Approximately 23% of participants had Gleason scores 7–10, and 5 of 8 deaths in the active surveillance group were in this subset. Patient-reported outcomes were compared among the 3 groups.[203] The operation group experienced the greatest negative effect on sexual function and urinary continence, whereas bowel function was worst in the radiation group.

In addition, studies have shown that active surveillance does not adversely impact psychological wellbeing or QOL.[203-208] Possible disadvantages of active surveillance are listed in the *Principles* section of the algorithm and include the possible necessity of follow-up prostate biopsies.

### Rationale

The NCCN Guidelines Panel remains concerned about the problems of overtreatment related to the increased frequency of diagnosis of prostate cancer from widespread use of PSA for early detection or screening (see the NCCN Guidelines for Prostate Cancer Early Detection, available at www.NCCN.org).

The debate about the need to diagnose and treat every man who has prostate cancer is fueled by the high prevalence of prostate cancer upon autopsy of the prostate[209]; the high frequency of positive prostate biopsies in men with normal DREs and serum PSA values[210]; the contrast between the incidence and mortality rates of prostate cancer; and the need to treat an estimated 37 men with screen-detected prostate cancer[211,212] or 100 men with low-risk prostate cancer[213] to prevent one death from the disease. The controversy regarding overtreatment of prostate cancer and the value of prostate cancer early detection[211-217] has been further informed by publication of the Goteborg study, a subset of the European

Randomized Study of Screening for Prostate Cancer (ERSPC).[218,219] Many believe that this study best approximates proper use of PSA for early detection because it was population-based and involved a 1:1 randomization of 20,000 men who received PSA every 2 years and used thresholds for prostate biopsy of PSA >3 and >2.5 since 2005. The 14-year follow-up reported in 2010 was longer than the European study as a whole (9 years) and the Prostate, Lung, Colorectal, and Ovarian (PLCO) trial (11.5 years). Prostate cancer was diagnosed in 12.7% of the screened group compared to 8.2% of the control group. Prostate cancer mortality was 0.5% in the screened group and 0.9% in the control group, which gave a 40% absolute cumulative risk reduction of prostate cancer death (compared to ERSPC 20% and PLCO 0%).[218] Most impressively, 40% of the patients were initially managed using active surveillance and 28% were still on active surveillance at the time these results were analyzed. To prevent a prostate cancer death, 12 men would need to be diagnosed and treated as opposed to the ERSPC as a whole where 37 men needed to be treated. Analysis of 18-year follow-up data from the Goteborg study reduced the number needed to be diagnosed to prevent 1 prostate cancer death to 10.[220] Thus, early detection, when applied properly, should reduce prostate cancer mortality. However, that reduction comes at the expense of overtreatment that may occur in as many as 50% of men treated for PSA-detected prostate cancer.[221]

The best models of prostate cancer detection and progression estimate that 23% to 42% of all U.S. screen-detected cancers were overtreated[222] and that PSA detection was responsible for up to 12.3 years of lead-time bias.[223] The NCCN Guidelines Panel responded to these evolving data with careful consideration of which men should be recommended active surveillance. However, the NCCN Guidelines Panel recognizes the uncertainty associated with the estimation of chance of competing causes of death; the definition of very-low-, low-, and favorable intermediate-risk prostate cancer; the ability to detect disease progression without compromising chance of cure; and the chance and consequences of treatment side effects.

### Patient Selection

Epstein and colleagues[224] introduced clinical criteria to predict pathologically “insignificant” prostate cancer. Insignificant prostate cancer is identified by: clinical stage T1c, biopsy Grade Group I, the presence of disease in fewer than 3 biopsy cores, ≤50% prostate cancer involvement in any core, and PSA density <0.15 ng/mL/g. Despite the usefulness of these criteria, physicians are cautioned against using these as the sole decision maker. Studies have shown that as many as 8% of cancers that qualified as insignificant using the Epstein criteria were not organ-confined based on postoperative findings.[225,226] A new nomogram may be better.[227] Although many variations upon this definition have been proposed (reviewed by Bastian and colleagues[228]), a consensus of the NCCN Guidelines Panel was reached that insignificant prostate cancer, especially when detected early using serum PSA, poses little threat to men with a life expectancy of <20 years. The confidence that Americans with very-low-risk prostate cancer have a very small risk of prostate cancer death is enhanced by lead time bias introduced by PSA early detection that ranges from an estimated 12.3 years in a 55-year-old man to 6 years in a 75-year-old man.[223] At this time, the NCCN Panel recommends active surveillance for all men with very-low-risk prostate cancer and life expectancy <20 years and believes that it should be considered for men with very-low-risk prostate cancer and life expectancy ≥20 years. The panel recommends active surveillance for all men with low- and favorable intermediate-risk prostate cancer and life expectancy <10 years and believes that it should be considered for men with low and favorable intermediate risk and life expectancy ≥10 years. The use of active surveillance in favorable intermediate-risk prostate cancer is discussed in detail in *Favorable Intermediate Risk*, below.

Race is emerging as an important factor to consider when contemplating active surveillance, particularly for African-American men. From 2010 to 2012, African-American men had a higher lifetime risk of developing (18.2% vs. 13.3%) and dying from (4.4% vs. 2.4%) prostate cancer compared to Caucasian-American men.[229] In one study, the increase in prostate-cancer-specific mortality in African-American men was limited to those with grade group 1.[230] Multiple studies have shown that African Americans with very-low-risk prostate cancer may harbor high-grade (Grade Group ≥2) cancer that is not detected by pre-treatment biopsies. Compared to Caucasian Americans matched on clinical parameters, African Americans have been reported to have a 1.7- to 2.3-fold higher change of pathologic upgrading.[231,232] However, other studies have not seen different rates of upstaging or upgrading.[233,234] For example, in a retrospective study of 895 men in the SEARCH database, no significant differences were seen in the rates of pathologic upgrading, upstaging, or biochemical recurrence between African American and Caucasian Americans.[233] Several studies have reported that, among men with low-risk prostate cancer who are enrolled in active surveillance programs, African Americans have higher risk of disease progression to higher Gleason grade or volume cancer than Caucasian Americans.[235-237] African Americans in the low- to intermediate-risk categories also appear to suffer from an increased risk of biochemical recurrence after treatment.[238] In addition, African American men with low-risk or favorable intermediate-risk prostate cancer have an increase in all-cause mortality after treatment, mainly due to cardiovascular complications after ADT.[239] Reasons for these clinical disparities are under investigation and may include difference in tumor location within the prostate that may reflect different prostate cancer subtypes related to differences in gene expression.[240-243] In addition, treatment disparities and access to health care may play a significant role.[244,245] Strategies to improve risk-stratification for African Americans considering active surveillance may include mpMRI in concert with targeted image-guided biopsies, which have been reported to improve detection of clinically significant tumors in some men.[246]

The proportion of men with low-risk prostate cancer choosing active surveillance in the Veterans Affairs Integrated Health Care System increased from 2005 to 2015: from 4% to 39% of men <65 years and from 3% to 41% of men ≥65 years.[247] An analysis of the SEER database found a similar trend, with the use of active surveillance in men with low-risk prostate cancer increasing from 14.5% in 2010 to 42.1% in 2015.[248] An international, hospital-based, retrospective analysis of >115,000 men with low-risk prostate cancer reported that active surveillance utilization increased, but the proportions were lower at 7% in 2010 and 20% in 2014.[249] Ultimately, a recommendation for active surveillance must be based on careful individualized weighing of a number of factors: life expectancy, general health condition, disease characteristics, potential side effects of treatment, and patient preference.

### Surveillance Program and Reclassification Criteria

Before starting on an active surveillance program, mpMRI and/or prostate biopsy should be considered to confirm candidacy for active surveillance. Men with PI-RADS 4 or 5 on mpMRI have an increased risk of biopsy progression during active surveillance.[250]

The current NCCN recommendations for the active surveillance program include PSA no more often than every 6 months unless clinically indicated; DRE no more often than every 12 months unless clinically indicated; repeat prostate biopsy no more often than every 12 months unless clinically indicated; and repeat mpMRI no more often than every 12 months unless clinically indicated.

Results of a study of 211 patients with Grade Group 1 prostate cancer who had initial and repeat mpMRIs and PSA monitoring suggest that a negative initial mpMRI predicts a low risk of Gleason upgrading by systematic biopsy.[251] In addition, PSA velocity was significantly associated with subsequent progression in those with an initial negative mpMRI. In contrast, those with high-risk visible lesions on mpMRI before initiation of active surveillance had an increased risk of progression. A meta-analysis of 43 studies found the sensitivity and NPV for mpMRI to be 0.81 and 0.78, respectively.[252]

Early experience supports the utilization of mpMRI in biopsy protocols to better risk-stratify men under active surveillance.[253-255] However, more recent studies have shown that a significant proportion of high-grade cancers are detected with systematic biopsy and not targeted biopsy in men on active surveillance.[256-258]

A repeat prostate biopsy should be considered if the prostate exam changes, if mpMRI (if done) suggests more aggressive disease, or if PSA increases, but no parameter is very reliable for detecting prostate cancer progression. Furthermore, a repeat prostate biopsy should be considered to assess for disease progression regardless of these changes, but no more often than every 12 months, because PSA kinetics may not be reliable for predicting progression. Repeat biopsy is useful to determine whether higher Gleason grade elements, which may influence prognosis and hence the decision to continue active surveillance or proceed to definitive local therapy, are evolving although the risk appears small.[259]

Each of the major active surveillance series has used different criteria for reclassification.[197,199,260-264] Reclassification criteria were met by 23% of men with a median follow-up of 7 years in the Toronto experience,[262] 36% of men with a median follow-up of 5 years in the Johns Hopkins experience,[199] and 16% of men with a median follow-up of 3.5 years in the University of California, San Francisco (UCSF) experience[261] (Table 3). Uncertainty regarding reclassification criteria and the desire to avoid missing an opportunity for cure drove several reports that dealt with the validity of commonly used reclassification criteria. The Toronto group demonstrated that a PSA trigger point of PSADT <3 years could not be improved upon by using a PSA threshold of 10 or 20, PSADT calculated in various ways, or PSA velocity >2 ng/mL/y.[265] The Johns Hopkins group used biopsy-demonstrated reclassification to Gleason pattern 4 or 5 or increased tumor volume on biopsy as their criteria for reclassification. Of 290 men on an annual prostate biopsy program, 35% demonstrated reclassification at a median follow-up of 2.9 years.[266] Neither PSADT (area under the curve [AUC], 0.59) nor PSA velocity (AUC, 0.61) was associated with prostate biopsy reclassification. Both groups have concluded that PSA kinetics cannot replace regular prostate biopsy, although treatment of most men who demonstrate reclassification on prostate biopsy prevents evaluation of biopsy reclassification as a criterion for treatment or reduction of survival. Treatment of all men who developed Gleason pattern 4 on annual prostate biopsies has thus far resulted in only 2 prostate cancer deaths among 1298 men (0.15%) in the Johns Hopkins study.[199] However, it remains uncertain whether treatment of all who progressed to Gleason pattern 4 was necessary. Studies remain in progress to identify the best trigger points when interventions with curative intent may still be successful.

The Toronto group published findings on 3 patients who died of prostate cancer in their experience with 450 men on active surveillance.[262] These 3 deaths led them to revise their criteria for offering men active surveillance, because each of these 3 men probably had metastatic disease at the time of entry on active surveillance. The 450 men were followed for a median of 6.8 years; OS was 78.6% and prostate cancer-specific survival was 97.2%.[262] Of the 30% (n = 145) of men who progressed, 8% had an increase in Gleason grade, 14% had a PSADT <3 years, 1% developed a prostate nodule, and 3% were treated because of anxiety. One hundred thirty-five of these 145 men were treated: 35 by radical prostatectomy, 90 by EBRT with or without ADT, and 10 with ADT alone. Follow-up is available for 110 of these men, and 5-year biochemical progression-free survival is 62% for those undergoing radical prostatectomy and 43% for those undergoing radiation. Longer-term follow-up of this cohort was reported in 2015.[197] The 10- and 15-year actuarial cause-specific survival rates for the entire cohort were 98.1% and 94.3 %, respectively. Only 15 of 993 (1.5%) patients had died of prostate cancer, an additional 13 men (1.3%) had developed metastatic disease, and only 36.5% of the cohort had received treatment by 10 years. In an analysis of 592 patients enrolled in this cohort who had ≥1 repeat prostate biopsy, 31.3% of cases were upgraded. Fifteen percent of upgraded cases were upgraded to Gleason ≥8, and 62% of total upgraded cases proceeded to active treatment.[267] Another analysis of this cohort revealed that metastatic disease developed in 13 of 133 men with Gleason 7 disease (9.8%) and 17 of 847 men with Gleason ≤6 disease (2.0%).[268] PSADT and the number of positive scores were also predictors of increased risk for the development of metastatic disease.

In comparison, among 192 men on active surveillance who underwent delayed treatment at a median of 2 years after diagnosis in the Johns Hopkins experience, 5-year biochemical progression-free survival was 96% for those who underwent radical prostatectomy and 75% for those who underwent radiation.[264] The two groups were similar by pathologic Gleason grade, pathologic stage, and margin positivity. All men treated by radical prostatectomy after progression on active surveillance had freedom from biochemical progression at a median follow-up of 37.5 months, compared to 97% of men in the primary radical prostatectomy group at a median follow-up of 35.5 months. A later publication from this group showed that 23 of 287 men who were treated after active surveillance (8%) experienced biochemical recurrence, and the rate was independent of the type of treatment.[199] Several studies have shown that delayed radical prostatectomy does not increase the rates of adverse pathology.[269-272]

The panel believes there is an urgent need for further clinical research regarding the criteria for recommending active surveillance, the criteria for reclassification on active surveillance, and the schedule for active surveillance especially as it pertains to prostate biopsies, which pose an increasing burden. One such study is a prospective multi-institutional cohort study, which has been funded by the NCI.[271] Nine hundred and five men, median age 63 years and median follow-up 28 months, demonstrated 19% conversion to therapy. Much should be learned about the criteria for selection of and progression on active surveillance as this cohort and research effort mature. Literature suggests that as many as 7% of men undergoing prostate biopsy will suffer an adverse event,[215] and those who develop urinary tract infection are often fluoroquinolone-resistant.[273] Radical prostatectomy may become technically challenging after multiple sets of biopsies, especially as it pertains to potency preservation.[274]

## Radical Prostatectomy

Radical prostatectomy is appropriate for any patient whose cancer appears clinically localized to the prostate. However, because of potential perioperative morbidity, radical prostatectomy should be reserved for patients whose life expectancy is 10 years or more. Stephenson and colleagues[107] reported a low 15-year prostate cancer-specific mortality of 12% in patients who underwent radical prostatectomy (5% for patients with low-risk disease), although it is unclear whether the favorable prognosis is due to the effectiveness of the procedure or the low lethality of cancers detected in the PSA era.

Radical prostatectomy was compared to watchful waiting in a randomized trial of 695 patients with early-stage prostate cancer (mostly T2).[275,276] With a median follow-up of 12.8 years, those assigned to the radical prostatectomy group had significant improvements in disease-specific survival, OS, and risk of metastasis and local progression.[275] The reduction in mortality was confirmed at 18 years of follow-up, with an absolute difference of 11%.[276] Overall, 8 men needed to be treated to avert one death; that number fell to 4 for men younger than 65 years of age. Longer follow-up results were also reported, in which the cumulative incidence of death from prostate cancer was 19.6% and 31.3% in the radical prostatectomy and watchful waiting groups, respectively, at 23 years, with a mean increase of 2.9 years of life in the radical prostatectomy group.[277] The results of this trial offer high-quality evidence to support radical prostatectomy as a treatment option for clinically localized prostate cancer.

Some patients at high or very high risk may benefit from radical prostatectomy. In an analysis of 842 men with Gleason scores 8 to 10 at biopsy who underwent radical prostatectomy, predictors of unfavorable outcome included PSA level over 10 ng/mL, clinical stage T2b or higher, Gleason score 9 or 10, higher number of biopsy cores with high-grade cancer, and over 50% core involvement.[278] Patients without these characteristics showed higher 10-year biochemical-free and disease-specific survival after radical prostatectomy compared to those with unfavorable findings (31% vs. 4% and 75% vs. 52%, respectively). Radical prostatectomy is an option for men with high-risk disease and in select patients with very-high-risk disease.

Radical prostatectomy is a salvage option for patients experiencing biochemical recurrence after primary EBRT, but morbidity (incontinence, erectile dysfunction, and bladder neck contracture) remains significantly higher than when radical prostatectomy is used as initial therapy.[279,280] Overall and cancer-specific 10-year survival ranged from 54% to 89% and 70% to 83%, respectively.[279] Patient selection is important, and salvage prostatectomy should only be performed by highly experienced surgeons.

### Operative Techniques and Adverse Effects

Long-term cancer control has been achieved in most patients with both the retropubic and the perineal approaches to radical prostatectomy; high-volume surgeons in high-volume centers generally achieve superior outcomes.[281,282] Laparoscopic and robot-assisted radical prostatectomy are commonly used and are considered comparable to conventional approaches in experienced hands.[283-285] In a cohort study using SEER Medicare-linked data on 8837 patients, minimally invasive compared to open radical prostatectomy was associated with shorter length of hospital stay, less need for blood transfusions, and fewer surgical complications, but rates of incontinence and erectile dysfunction were higher.[286] A second large study reported no difference in overall complications, readmission, and additional cancer therapies between open and robot-assisted radical prostatectomy, although the robotic approach was associated with higher rates of genitourinary complications and lower rates of blood transfusion.[287] Oncologic outcome of a robotic versus open approach was similar when assessed by use of additional therapies[286] or rate of positive surgical margins,[288] although longer follow-up is necessary. A meta-analysis on 19 observational studies (n = 3893) reported less blood loss and lower transfusion rates with minimally invasive techniques than with open operation.[288] Risk of positive surgical margins was the same. Two more recent meta-analyses showed a statistically significant advantage in favor of a robotic approach compared to an open approach in 12-month urinary continence[289] and potency recovery.[290] Early results from a randomized controlled phase 3 study comparing robot-assisted laparoscopic radical prostatectomy and open radical retropubic prostatectomy in 326 men were published in 2016.[291,292] Urinary function and sexual function scores and rates of postoperative complications did not differ significantly between the groups at 6, 12, and 24 months after surgery. Rates of positive surgical margins were similar, based on a superiority test (10% in the open group vs. 15% in the robotic group). Assessment of oncologic outcomes from this trial will be limited because postoperative management and additional cancer therapies were not standardized between the groups.[291]

An analysis of the Prostate Cancer Outcomes Study on 1655 men with localized prostate cancer compared long-term functional outcomes after radical prostatectomy or EBRT.[293] At 2 and 5 years, patients who underwent radical prostatectomy reported higher rates of urinary incontinence and erectile dysfunction but lower rates of bowel urgency. However, no significant difference was observed at 15 years. In a large retrospective cohort study involving 32,465 patients, those who received EBRT had a lower 5-year incidence of urological procedures than those who underwent radical prostatectomy, but higher incidence for hospital admissions, rectal or anal procedures, open surgical procedures, and secondary malignancies.[294]

Return of urinary continence after radical prostatectomy may be improved by preserving the urethra beyond the prostatic apex and by avoiding damage to the distal sphincter mechanism. Bladder neck preservation may allow more rapid recovery of urinary control.[295] Anastomotic strictures that increase the risk of long-term incontinence are less frequent with modern surgical techniques. Recovery of erectile function is related directly to the degree of preservation of the cavernous nerves, age at surgery, and preoperative erectile function. Improvement in urinary and sexual function has been reported with nerve-sparing techniques.[296,297] Replacement of resected nerves with nerve grafts does not appear to be effective for patients undergoing wide resection of the neurovascular bundles.[298] The ability of mpMRI to detect extracapsular extension can aid in decision-making in nerve-sparing surgery.[159]

### Pelvic Lymph Node Dissection

The decision to perform PLND should be guided by the probability of nodal metastases. The NCCN Guidelines Panel chose 2% as the cutoff for PLND because this avoids 47.7% of PLNDs at a cost of missing 12.1% of positive pelvic lymph nodes.[112] A more recent analysis of 26,713 patients in the SEER database treated with radical prostatectomy and PLND between 2010 and 2013 found that the 2% nomogram threshold would avoid 22.3% of PLNDs at a cost of missing 3.0% of positive pelvic lymph nodes.[299] The panel recommends use of a nomogram developed at Memorial Sloan Kettering Cancer Center that uses pretreatment PSA, clinical stage, and Gleason sum to predict the risk of pelvic lymph node metastases.[112]

PLND should be performed using an extended technique.[300,301] An extended PLND includes removal of all node-bearing tissue from an area bounded by the external iliac vein anteriorly, the pelvic side wall laterally, the bladder wall medially, the floor of the pelvis posteriorly, Cooper's ligament distally, and the internal iliac artery proximally. Removal of more lymph nodes using the extended technique has been associated with increased likelihood of finding lymph node metastases, thereby providing more complete staging.[302-304] A survival advantage with more extensive lymphadenectomy has been suggested by several studies, possibly due to elimination of microscopic metastases,[303,305-307] although definitive proof of oncologic benefit is lacking.[308] PLND can be performed safely laparoscopically, robotically, or as an open procedure, and complication rates should be similar among the three approaches.

## Radiation Therapy

RT techniques used in prostate cancer include EBRT, proton radiation, and brachytherapy. EBRT techniques include IMRT and hypofractionated, image-guided SBRT. An analysis that included propensity-score matching of patients showed that, among younger men with prostate cancer, SBRT and IMRT had similar toxicity profiles whereas proton radiation was associated with reduced urinary toxicity and increased bowel toxicity. The cost of proton therapy was almost double that of IMRT, and SBRT was slightly less expensive.[309]

The panel believes that highly conformal RT (CRT) techniques should be used to treat localized prostate cancer. Photon and proton beam radiation are both effective at achieving highly CRT with acceptable and similar biochemical control and long-term side effect profiles. Radiation techniques are discussed in more detail below.

### External Beam Radiation Therapy

Over the past several decades, EBRT techniques have evolved to allow higher doses of radiation to be administered safely. Three-dimensional (3D) CRT (3D-CRT) uses computer software to integrate CT images of the patients' internal anatomy in the treatment position, which allows higher cumulative doses to be delivered with lower risk of late effects.[123,310-312] The second-generation 3D technique, intensity-modulated RT (IMRT), has been used increasingly in practice.[313] IMRT reduced the risk of gastrointestinal toxicities and rates of salvage therapy compared to 3D-CRT in some but not all older retrospective and population-based studies, although treatment cost is increased.[314-317] More recently, moderately hypofractionated image-guided IMRT regimens (2.4–4 Gy per fraction over 4–6 weeks) have been tested in randomized trials, and their efficacy has been similar or non-inferior to conventionally fractionated IMRT, with one trial showing fewer treatment failures with a moderately fractionated regimen.[318-327] Toxicity was similar between moderately hypofractionated and conventional regimens in some[318,322,325,326] but not all of the trials.[320,323,324] In addition, efficacy results varied among the trials, with some showing noninferiority or similar efficacy and others showing that hypofractionation may be less effective than conventional fractionation schemes. These safety and efficacy differences are likely a result of differences in fractionation schedules.[328] Overall, the panel believes that hypofractionated IMRT techniques, which are more convenient for patients, can be considered as an alternative to conventionally fractionated regimens when clinically indicated. The panel lists fractionation schemes that have shown acceptable efficacy and toxicity on PROS-D page 3 of 5 in the algorithm above. An ASTRO/ASCO/AUA evidence-based guideline regarding the use of hypofractionated radiation in men with localized prostate cancer concluded that moderately fractionated regimens are justified for routine use in this setting and provides more detail on the topic.[329]

Daily prostate localization using image-guided RT (IGRT) is essential with either 3D-CRT or IMRT for target margin reduction and treatment accuracy. Imaging techniques, such as ultrasound, implanted fiducials, electromagnetic targeting and tracking, or endorectal balloon, can improve cure rates and decrease complications.

These techniques have permitted safer dose escalation, and results of randomized trials have suggested that dose escalation is associated with improved biochemical outcomes.[330-335] Kuban and colleagues[333] published an analysis of their dose-escalation trial of 301 patients with stage T1b to T3 prostate cancer. Freedom from biochemical or clinical recurrence was higher in the group randomized to 78 Gy compared to 70 Gy (78% vs. 59%, *P* = .004) at a median follow-up of 8.7 years. The difference was even greater among patients with diagnostic PSA >10 ng/mL (78% vs. 39%, *P* = .001). An analysis of the National Cancer Database found that dose escalation (75.6–90 Gy) resulted in a dose-dependent improvement in OS for men with intermediate- or high-risk prostate cancer.[336] In light of these findings, the conventional 70 Gy dose is no longer considered adequate. A dose of 75.6 to 79.2 Gy in conventional fractions to the prostate (with or without seminal vesicles) is appropriate for patients with low-risk cancers. Intermediate-risk and high-risk patients should receive doses of up to 81.0 Gy.[314,337,338]

Data suggested that EBRT and radical prostatectomy were effective for the treatment of localized prostate cancer.[339] EBRT of the primary prostate cancer shows several distinct advantages over radical prostatectomy. EBRT avoids complications associated with operation, such as bleeding and transfusion-related effects, and risks associated with anesthesia, such as myocardial infarction and pulmonary embolus. 3D-CRT and IMRT techniques are widely available and are possible for patients over a wide range of ages. EBRT has a low risk of urinary incontinence and stricture and a good chance of short-term preservation of erectile function.[340]

The disadvantages of EBRT include a treatment course of 8 to 9 weeks. Up to 50% of patients have some temporary bladder or bowel symptoms during treatment. There is a low but definite risk of protracted rectal symptoms from radiation proctitis, and the risk of erectile dysfunction increases over time.[340,341] The risk of late rectal complications following RT is related to the volume of the rectum receiving doses of radiation close to or exceeding the radiation dose required to control the primary tumor. Biomaterials have been developed, tested, and FDA approved to serve as spacer materials when inserted between the rectum and prostate.[342] In a randomized phase 3 multicenter clinical trial of patients undergoing image-guided intensity-modulated RT (IG-IMRT), with the risk of late (3-year) common terminology criteria for adverse events (CTCAE) grade 2 or higher, physician-recorded rectal complications declined from 5.7% to 0% in the control versus hydrogel spacer group.[343] The hydrogel spacer group had a significant reduction in bowel QOL decline. No significant differences in adverse events were noted in those receiving hydrogel placement versus controls. Results of a secondary analysis of this trial suggest that use of a spacer may decrease the sexual side effects of radiation.[344]

If the cancer recurs, salvage radical prostatectomy is associated with a higher risk of complications than primary radical prostatectomy.[345]

Contraindications to EBRT include prior pelvic irradiation, active inflammatory disease of the rectum, or a permanent indwelling Foley catheter. Relative contraindications include very low bladder capacity, chronic moderate or severe diarrhea, bladder outlet obstruction requiring a suprapubic catheter, and inactive ulcerative colitis.

#### *EBRT for Early Disease*

EBRT is one of the principal treatment options for clinically localized prostate cancer. The NCCN Guidelines Panel consensus was that modern EBRT and surgical series show similar progression-free survival in patients with low-risk disease treated with radical prostatectomy or EBRT. In a study of 3546 patients treated with brachytherapy plus EBRT, disease-free survival (DFS) remained steady at 73% between 15 and 25 years of follow-up.[346] The panel lists several acceptable dosing schemas in the guidelines. The NRG Oncology/RTOG 0126 randomized clinical trial compared 79.2 Gy (44 fractions) and 70.2 Gy (39 fractions), both in 1.8 Gy fractions, in 1499 men with intermediate-risk prostate cancer.[347] After a median follow-up of 8.4 years, the escalated dose reduced biochemical recurrences, but increased late toxicity and had no effect on OS.

#### *EBRT for Patients with High-Risk or Very-High-Risk Disease*

EBRT has demonstrated efficacy in patients at high risk and very high risk. One study randomized 415 patients to EBRT alone or EBRT plus 3-year ADT.[348] In another study (RTOG 8531), 977 patients with T3 disease treated with EBRT were randomized to adjuvant ADT or ADT at relapse.[349] Two other randomized phase 3 trials evaluated long-term ADT with or without radiation in a population of patients who mostly had T3 disease.[350-353] In all four studies, the combination group showed improved disease-specific survival and OS compared to single-modality treatment. Patients with a PSA nadir >0.5 ng/mL after radiation and 6 months of ADT have an adjusted hazard ratio (HR) for all-cause mortality of 1.72 (95% CI, 1.17–2.52; *P* = .01) compared with patients who received radiation only.[354]

### *EBRT for Node-Positive Disease*

See *Adjuvant or Salvage Therapy After Radical Prostatectomy* under *NCCN Recommendations*.

### *EBRT to the Primary Tumor in Low-Volume M1 Disease*

Patients with newly diagnosed, low-volume metastatic prostate cancer can be considered for ADT with EBRT to the primary tumor based on results from the randomized controlled phase 3 STAMPEDE trial.[355] In this multicenter, international study, 2061 patients were randomized to lifelong ADT with or without EBRT to the primary tumor (either 55 Gy in 20 daily fractions over 4 weeks or 36 Gy in 6 weekly fractions over 6 weeks). The primary outcome of OS by intention-to-treat analysis was not met (HR, 0.92; 95% CI, 0.80–1.06; *P* = .266), but EBRT improved the secondary outcome of failure-free survival (FFS; HR, 0.76; 95% CI, 0.68–0.84; *P* < .0001). In a pre-planned subset analysis, outcomes of patients with high metastatic burden (defined as visceral metastases; ≥4 bone metastases with ≥1 outside the vertebral bodies or pelvis; or both) and those with low metastatic burden (all others) were determined. EBRT improved OS (adjusted HR, 0.68; 95% CI, 0.52–0.90), prostate cancer-specific survival (adjusted HR, 0.65; 95% CI, 0.47–0.90), FFS (adjusted HR, 0.59; 95% CI, 0.49–0.72), and progression-free survival (adjusted HR, 0.78; 95% CI, 0.63–0.98) in patients with low metastatic burden, but not in patients with high metastatic burden. Randomized clinical trials are ongoing to better test the value of removal or radiation of the primary tumor in patients with low metastatic burden who are beginning ADT.[356-360]

The panel recommends against EBRT to the primary tumor in the case of high-volume M1 disease based on the HORRAD and STAMPEDE trials.[355,361] No improvement in OS was seen from the addition of EBRT to the primary when combined with standard systemic therapy in patients with high-volume M1 disease in either trial.

## Stereotactic Body Radiation Therapy

The relatively slow proliferation rate of prostate cancer is reflected in a low α/β ratio,[362] most commonly reported between 1 and 4. These values are similar to that for the rectal mucosa. Because the α/β ratio for prostate cancer is similar to or lower than the surrounding tissues responsible for most of the toxicity reported with radiation, appropriately designed radiation treatment fields and schedules using extremely hypofractionated regimens should result in similar cancer control rates without increased risk of late toxicity.

Stereotactic body RT (SBRT) is a technique that delivers highly conformal, high-dose radiation in 5 or fewer treatment fractions, which are safe to administer only with precise, image-guided delivery.[363] Single-institution series with median follow-up as long as 6 years report excellent biochemical progression-free survival and similar early toxicity (bladder, rectal, and QOL) compared to standard radiation techniques.[362-368] According to a pooled analysis of phase 2 trials, the 5-year biochemical relapse-free survival is 95%, 84%, and 81% for patients with low-, intermediate-, and high-risk disease, respectively.[369] A study of individual patient data from a cohort of 2142 patients with low or intermediate-risk prostate cancer from 10 single institution phase 2 trials and 2 multi-institutional phase 2 trials found that the 7-year cumulative rates of biochemical recurrence were 4.5%, 8.6%, and 14.9% for low-risk disease, favorable intermediate risk disease, and unfavorable intermediate risk disease, respectively.[370] Severe acute toxicity was rare, at 0.6% for grade 3 or higher genitourinary toxic events and 0.09% for grade 3 or higher gastrointestinal toxic events. Late (7-year cumulative incidence) toxicity rates were 2.4% and 0.4% for grade 3 or higher genitourinary toxic events and gastrointestinal toxic events, respectively.

SBRT may be associated with more toxicity than moderately fractionated IMRT. One retrospective study of 4005 patients reported higher genitourinary toxicity at 24 months after SBRT than IMRT (44% vs. 36%; *P* = .001).[371] Another phase 2 trial found increased toxicity with doses >47.5 Gy delivered in 5 fractions.[372] An analysis using the SEER database also reported that SBRT was more toxic than IMRT.[373]

A phase 3 trial has been initiated that is comparing 38 Gy in 5 fractions with 79.2 Gy in 44 fractions.[374] Preliminary results show that the cumulative incidence of grade 2 or higher genitourinary and bowel toxicity was similar between the arms after median follow-up of 36 months in 75 patients.

SBRT/extremely hypofractionated image-guided IMRT regimens (6.5 Gy per fraction or greater) can be considered as an alternative to conventionally fractionated regimens at clinics with appropriate technology, physics, and clinical expertise. Longer follow-up and prospective multi-institutional data are required to evaluate longer-term results, especially because late toxicity theoretically could be worse in hypofractionated regimens compared to conventional fractionation (1.8–2.0 Gy per fraction).

## Brachytherapy

Brachytherapy involves placing radioactive sources into the prostate tissue. Brachytherapy has been used traditionally for low-risk cases because earlier studies found it less effective than EBRT for high-risk disease.[81,375] However, increasing evidence suggests that technical advancements in brachytherapy may provide a role for contemporary brachytherapy in high-risk localized and locally advanced prostate cancer.[376,377]

The advantage of brachytherapy is that the treatment is completed in 1 day with little time lost from normal activities. In appropriate patients, the cancer-control rates appear comparable to radical prostatectomy (over 90%) for low-risk prostate cancer with medium-term follow-up.[378] In addition, the risk of incontinence is minimal in patients without a previous transurethral resection of the prostate (TURP), and erectile function is preserved in the short term.[341] Disadvantages of brachytherapy include the requirement for general anesthesia and the risk of acute urinary retention. Irritative voiding symptoms may persist for as long as 1 year after implantation. The risk of incontinence is greater after TURP because of acute retention and bladder neck contractures, and many patients develop progressive erectile dysfunction over several years. IMRT causes less acute and late genitourinary toxicity and similar freedom from biochemical recurrence compared with iodine-125 or palladium-103 permanent seed implants.[379,380] Current brachytherapy techniques attempt to improve the radioactive seed placement and radiation dose distribution.

There are currently two methods for prostate brachytherapy: low dose-rate (LDR) and high dose-rate (HDR). LDR brachytherapy consists of placement of permanent seed implants in the prostate. The short range of the radiation emitted from these low-energy sources allows delivery of adequate dose levels to the cancer within the prostate, with excessive irradiation of the bladder and rectum avoided. Post-implant dosimetry should be performed to document the quality of an LDR implant.[381] HDR brachytherapy, which involves temporary insertion of a radiation source, is a newer approach.

Two groups have observed a lower risk of urinary frequency, urgency, and rectal pain with HDR brachytherapy compared with LDR brachytherapy (permanent seed implant).[382,383] Vargas and colleagues[384] reported that HDR brachytherapy results in a lower risk of erectile dysfunction than LDR brachytherapy. Commonly prescribed doses for LDR and HDR brachytherapy are listed in the guidelines.

For patients with very large or very small prostates, symptoms of bladder outlet obstruction (high International Prostate Symptom Score), or a previous TURP, seed implantation may be more difficult. These patients also have an increased risk of side effects. Neoadjuvant ADT may be used to shrink the prostate to an acceptable size; however, increased toxicity is expected from ADT, and prostate size may not decline in some men. The potential toxicity of ADT must be weighed against the possible benefit of target reduction.

Ideally, the accuracy of brachytherapy treatment should be verified by daily prostate localization with techniques of IGRT: CT, ultrasound, implanted fiducials, or electromagnetic targeting/tracking. Endorectal balloons may be used to improve prostate immobilization. Perirectal spacer materials (discussed under *External Beam Radiation Therapy*, above) may be employed when the previously mentioned techniques are insufficient to improve oncologic cure rates and/or reduce side effects due to anatomic geometry or other patient-related factors (eg, medication usage, comorbid conditions). Patients with obvious rectal invasion or visible T3 and posterior extension should not undergo perirectal spacer implantation.

***Brachytherapy Alone for Localized Disease***

Brachytherapy alone is an option for patients with very low, low, or favorable intermediate-risk prostate cancer, depending on life expectancy. Patients with high-risk cancers are generally considered poor candidates for brachytherapy alone. Either LDR or HDR brachytherapy can be used in this setting.

Retrospective analyses show that LDR or HDR brachytherapy alone can be effective and well tolerated in this population.[385-388] A phase 2 trial in 300 patients with intermediate-risk prostate cancer also found LDR brachytherapy alone to be safe and effective.[389] However, randomized controlled trials comparing brachytherapy to radical prostatectomy or EBRT in this population are limited. In a single-center trial, 165 patients with low-risk prostate cancer were randomized to LDR brachytherapy with iodine-125 seeds or radical prostatectomy. The 2-year biochemical FFS rates were similar between the groups at 96.1% after brachytherapy and 97.4% after radical prostatectomy ($P = .35$).[390] At 6 months follow-up, continence was better in the brachytherapy group whereas potency was better in the radical prostatectomy group.

***Brachytherapy Boost***

LDR or HDR brachytherapy can be added as a boost to EBRT plus ADT in men with unfavorable intermediate-, high-, or very-high-risk prostate cancer being treated with curative intent. Combining EBRT and brachytherapy allows dose escalation while minimizing acute or late toxicity in patients with high-risk localized or locally advanced cancer.[391-394] This combination has demonstrated improved biochemical control over EBRT plus ADT alone in randomized trials, but with higher toxicity.[395-397] An analysis of a cohort of 12,745 patients with high-risk disease found that treatment with brachytherapy (HR, 0.66; 95% CI, 0.49–0.86) or brachytherapy plus EBRT (HR, 0.77; 95% CI, 0.66–0.90) lowered disease-specific mortality compared to EBRT alone.[398]

The randomized ASCENDE-RT trial compared 2 methods of dose escalation in 398 men with intermediate- or high-risk prostate cancer: dose-escalated EBRT boost to 78 Gy or LDR brachytherapy boost.[399] All men were initially treated with 12 months of ADT and pelvic EBRT to 46 Gy. An intention-to-treat analysis found that the primary endpoint of biochemical progression-free survival was 89% versus 84% at 5 years; 86% versus 75% at 7 years; and 83% versus 62% at 9 years for the LDR versus EBRT boost arms (log-rank $P < .001$). Toxicity was higher in the brachytherapy arm, with the cumulative incidence of grade 3 genitourinary events at 5 years of 18.4% for brachytherapy boost and 5.2% for EBRT boost ($P < .001$).[400] A trend for increased gastrointestinal toxicity with brachytherapy boost was also seen (cumulative incidence of grade 3 events at 5 years, 8.1% vs. 3.2%; $P = .12$). However, at 6-year follow-up, health-related QOL was similar between the groups in most domains, except that physical and urinary function scales were significantly lower in the LDR arm.[401] Whereas the toxicity is increased with the use of brachytherapy boost, this and other randomized controlled trials have failed to show an improvement in overall or cancer-specific survival.[402]

Addition of ADT (2 or 3 years) to brachytherapy and EBRT is common for patients at high risk of recurrence. The outcome of trimodality treatment is excellent, with 9-year progression-free survival and disease-specific survival reaching 87% and 91%, respectively.[403,404] However, it remains unclear whether the ADT component contributes to outcome improvement. D'Amico and colleagues studied a cohort of 1342 patients with PSA over 20 ng/mL and clinical T3/T4 and/or Gleason score 8 to 10 disease.[405] Addition of either EBRT or ADT to brachytherapy did not confer an advantage over brachytherapy alone. The use of all three modalities reduced prostate cancer-specific mortality compared to brachytherapy alone (adjusted HR, 0.32; 95% CI, 0.14–0.73). Other analyses did not find an improvement in recurrence rate when ADT was added to brachytherapy and EBRT.[406,407]

A large, multicenter, retrospective cohort analysis that included 1809 men with Gleason score 9–10 prostate cancer found that multimodality therapy with EBRT, brachytherapy, and ADT was associated with improved prostate cancer-specific mortality and longer time to distant metastasis than either radical prostatectomy or EBRT with ADT.[408] In addition, an analysis of outcomes of almost 43,000 men with high-risk prostate cancer in the National Cancer Database found that mortality was similar in men treated with EBRT, brachytherapy, and ADT versus those treated with radical prostatectomy, but was worse in those treated with EBRT and ADT.[409]

#### *Salvage Brachytherapy*

Brachytherapy can be considered in men with biochemical recurrence after EBRT. In a retrospective study of 24 men who had EBRT as primary therapy and permanent brachytherapy after biochemical recurrence, the cancer-free and biochemical relapse-free survival rates were 96% and 88%, respectively, after a median follow-up of 30 months.[410] Results of a phase 2 study of salvage HDR brachytherapy after EBRT included relapse-free survival, distant metastases-free survival, and cause-specific survival rates of 68.5%, 81.5%, and 90.3%, respectively, at 5 years.[411] Toxicities were mostly grade 1 and 2 and included gastrointestinal toxicity and urethral strictures, and one case of Grade 3 urinary incontinence. In another prospective phase 2 trial, the primary endpoint of grade ≥3 late treatment-related gastrointestinal and genitourinary adverse events at 9 to 24 months post salvage brachytherapy was below the unacceptable threshold, at 14%.[412]

Data on the use of brachytherapy after permanent brachytherapy are limited, but the panel agrees that it can be considered for carefully selected patients. Decisions regarding the use of brachytherapy in the recurrent-disease setting should consider comorbidities, extent of disease, and potential complications. Brachytherapy in this setting is best performed at high-volume centers.

### Proton Therapy

Proton beam RT has been used to treat patients with cancer since the 1950s. Proponents of proton therapy argue that this form of RT could have advantages over x-ray (photon)-based radiation in certain clinical circumstances. Proton therapy and x-ray–based therapies like IMRT can deliver highly conformal doses to the prostate. Proton-based therapies will deliver less radiation dose to some of the surrounding normal tissues like muscle, bone, vessels, and fat not immediately adjacent to the prostate. These tissues do not routinely contribute to the morbidity of prostate radiation and are relatively resilient to radiation injury; therefore, the benefit of decreased dose to these types of normal, non-critical tissues has not been apparent. The critical normal structures adjacent to the prostate that can create prostate cancer treatment morbidity include the bladder, rectum, neurovascular bundles, and occasionally small bowel.

The weight of the current evidence about prostate cancer treatment morbidity supports the notion that the volume of the rectum and bladder that receives radiobiologically high doses of radiation near the prescription radiation dose accounts for the likelihood of long-term treatment morbidity, as opposed to higher volume, lower dose exposures. Numerous dosimetric studies have been performed trying to compare x-ray–based IMRT plans to proton therapy plans to illustrate how one or the other type of treatment can be used to spare the bladder or rectum from higher dose parts of the exposure. These studies suffer from the biases and talents of the investigators who plan and create computer models of dose deposition for one therapy or the other.[413] Although dosimetric studies in-silico can suggest that the right treatment planning can make an IMRT plan beat a proton therapy plan and vice-versa, they do not accurately predict clinically meaningful endpoints.

Comparative effectiveness studies have been published in an attempt to compare toxicity and oncologic outcomes between proton and photon therapies. Two comparisons between men treated with proton therapy or EBRT report similar early toxicity rates.[414,415] A prospective QOL comparison of patient-reported outcomes using the EPIC instrument between IMRT (204 patients) and proton therapy (1234 patients) concluded that “No differences were observed in summary score changes for bowel, urinary incontinence, urinary irritative/obstructive, and sexual domains between the 2 cohorts” after up to 2 years of follow-up.[416] A Medicare analysis of 421 men treated with proton therapy and a matched cohort of 842 men treated with IMRT showed less genitourinary toxicity at 6 months for protons, although the difference disappeared after 1 year.[415] No other significant differences were seen between the groups. In contrast, a single-center report of prospectively collected QOL data revealed significant problems with incontinence, bowel dysfunction, and impotence at 3 months, 12 months, and >2 years after treatment with proton therapy.[414] In that report, only 28% of men with normal erectile function maintained it after therapy. The largest retrospective comparative effectiveness analysis to date comparing IMRT to proton therapy was performed using SEER-Medicare claims data for the following long-term endpoints: gastrointestinal morbidity, urinary incontinence, non-incontinence urinary morbidity, sexual dysfunction, and hip fractures.[417] With follow-up as mature as 80 months and using both propensity scoring and instrumental variable analysis, the authors concluded that men receiving IMRT therapy had statistically significantly lower gastrointestinal morbidity than patients receiving proton therapy, whereas rates of urinary incontinence, non-incontinence urinary morbidity, sexual dysfunction, hip fractures, and additional cancer therapies were statistically indistinguishable between the cohorts. However, firm conclusions regarding differences in toxicity or effectiveness of proton and photon therapy cannot be drawn because of the limitations inherent in retrospective/observational studies.

The costs associated with proton beam facility construction and proton beam treatment are high compared to the expense of building and using the more common photon linear accelerator-based practice.[415] The American Society for Radiation Oncology (ASTRO) evaluated proton therapy and created a model policy to support the society’s position on payment coverage for proton beam therapy in 2014.[418] This model policy was updated in 2017 and recommends coverage of proton therapy for the treatment of non-metastatic prostate cancer if the patient is enrolled in either an institutional review board (IRB)-approved study or a multi-institutional registry that adheres to Medicare requirements for Coverage with Evidence Development (CED).[419] The policy states: “In the treatment of prostate cancer, the use of [proton beam therapy] is evolving as the comparative efficacy evidence is still being developed. In order for an informed consensus on the role of [proton beam therapy] for prostate cancer to be reached, it is essential to collect further data, especially to understand how the effectiveness of proton therapy compares to other RT modalities such as IMRT and brachytherapy. There is a need for more well-designed registries and studies with sizable comparator cohorts to help accelerate data collection. Proton beam therapy for primary treatment of prostate cancer should only be performed within the context of a prospective clinical trial or registry."

An ongoing prospective randomized trial is accruing patients to compare prostate proton therapy and prostate IMRT. The NCCN Panel believes no clear evidence supports a benefit or decrement to proton therapy over IMRT for either treatment efficacy or long-term toxicity. Conventionally fractionated prostate proton therapy can be considered a reasonable alternative to x-ray–based regimens at clinics with appropriate technology, physics, and clinical expertise.

## Radiation for Distant Metastases

Radiation is an effective means of palliating bone metastases from prostate cancer. Isolated symptomatic bone metastases can be managed with EBRT. Recent studies have confirmed the common practice in Canada and Europe of managing prostate cancer with bone metastases with a short course of radiation. A short course of 8 Gy x 1 is as effective as, and less costly than, 30 Gy in 10 fractions.[420] In a randomized trial of 898 patients with bone metastases, grade 2–4 acute toxicity was observed less often in the 8-Gy arm (10%) than the 30-Gy arm (17%) ($P$ = .002); however, the retreatment rate was higher in the 8-Gy group (18%) than in the 30-Gy group (9%) ($P$ < .001).[421] In another study of 425 patients with painful bone metastases, a single dose of 8 Gy was non-inferior to 20 Gy in multiple fractions in terms of overall pain response to treatment.[422] Most patients should be managed with a single fraction of 8 Gy for non-vertebral metastases based on therapeutic guidelines from the American College of Radiology.[423]

### *Radium-223 and Other Radiopharmaceuticals*

In May 2013, the U.S. Food and Drug Administration (FDA) approved radium-223 dichloride, an alpha particle-emitting radioactive agent. This first-in-class radiopharmaceutical was approved for treatment of metastatic CRPC in patients with symptomatic bone metastases and no known visceral metastatic disease. Approval was based on clinical data from a multicenter, phase 3, randomized trial (ALSYMPCA) that included 921 men with symptomatic CRPC, 2 or more bone metastases, and no known visceral disease.[424] Fifty-seven percent of the patients received prior docetaxel and all patients received best supportive care. Patients were randomized in a 2:1 ratio to 6 monthly radium-223 intravenous injections or placebo. Compared to placebo, radium-223 significantly improved OS (median 14.9 months vs. 11.3 months; HR, 0.70; 95% CI, 0.058–0.83; $P$ < .001) and prolonged time to first skeletal-related event (SRE) (median 15.6 months vs. 9.8 months). Preplanned subset analyses showed that the survival benefit of radium-223 was maintained regardless of prior docetaxel use.[425] Intention-to-treat analyses from ALSYMPCA showed that radium-223 also may reduce the risk of symptomatic SREs.[426] Grade 3/4 hematologic toxicity was low (3% neutropenia, 6% thrombocytopenia, and 13% anemia), likely due to the short range of radioactivity.[424] Fecal elimination of the agent led to generally mild non-hematologic side effects, which included nausea, diarrhea, and vomiting. Radium-223 was associated with improved or slower decline of QOL in ALSYMPCA.[427]

An international, open-label, single-arm phase 3b trial of radium-223 in symptomatic and asymptomatic patients treated in an early access program showed that radium-223 can be combined safely with abiraterone or enzalutamide and suggested that it can be administered safely to asymptomatic patients.[428] A phase 2 U.S. expanded access program also found that radium-223 with concurrent abiraterone or enzalutamide was safe.[429]

Beta-emitting radiopharmaceuticals are an effective and appropriate option for patients with widespread metastatic disease, particularly if they are no longer candidates for effective chemotherapy.[423] Because many patients have multifocal bone pain, systemic targeted treatment of skeletal metastases offers the potential of pain relief with minimal side effects. Unlike the alpha-emitting agent radium-223, beta emitters confer no survival advantage and are palliative. Beta-emitting radiopharmaceuticals developed for the treatment of painful bone metastases most commonly used for prostate cancer include strontium-89 (89Sr) or samarium-153 (153Sm).[430,431]

## Comparison of Treatment Options for Localized Disease

Several large prospective, population/cohort-based studies have compared the outcomes of patients with localized prostate cancer treated with EBRT, brachytherapy, radical prostatectomy, observation, and/or active surveillance. Barocas et al compared radical prostatectomy, EBRT, and active surveillance in 2550 men and found that, after 3 years, radical prostatectomy was associated with a greater decrease in urinary and sexual function than either EBRT or active surveillance.[432] Active surveillance, however, was associated with an increase in urinary irritative symptoms. Health-related QOL measures including bowel and hormonal function were similar among the groups, as was disease-specific survival.

Chen et al compared radical prostatectomy, EBRT, and brachytherapy against active surveillance in 1141 men.[433] As in the Barocas study, radical prostatectomy was associated with greater declines in sexual and urinary function than other treatments at 3 months. In this study, EBRT was associated with worse short-term bowel function, and both EBRT and brachytherapy were associated with worsened urinary obstructive and irritative symptoms. By 2 years, however, differences among the groups compared with active surveillance were insignificant. Results of a systematic review showed similar findings to these studies.[434]

## Other Local Therapies

Many therapies have been investigated for the treatment of localized prostate cancer in the initial disease and recurrent settings, with the goals of reducing side effects and matching the cancer control of other therapies. At this time, the panel recommends only cryosurgery and high-intensity focused ultrasound (HIFU) as options for RT recurrence in the absence of metastatic disease.

Cryosurgery, also known as cryotherapy or cryoablation, is an evolving minimally invasive therapy that damages tumor tissue through local freezing. In the initial disease setting, the reported 5-year biochemical disease-free rate after cryotherapy ranged from 65% to 92% in patients with low-risk disease using different definitions of biochemical recurrence.[435] A report suggests that cryotherapy and radical prostatectomy give similar oncologic results for unilateral prostate cancer.[436] A study by Donnelly and colleagues[437] randomly assigned 244 men with T2 or T3 disease to either cryotherapy or EBRT. All patients received neoadjuvant ADT. There was no difference in 3-year OS or DFS. Patients who received cryotherapy reported poorer sexual function.[438] For patients with locally advanced cancer, cryoablation was associated with lower 8-year biochemical progression-free rate compared to EBRT in a small trial of 62 patients, although disease-specific survival and OS were similar.[439]

Cryosurgery has been assessed in patients with recurrent disease after RT.[440-442] In one registry-based study of 91 patients, the biochemical DFS rates at 1, 3, and 5 years were 95.3%, 72.4%, and 46.5%, respectively.

Adverse events included urinary retention (6.6%), incontinence (5.5%), and rectourethral fistula (3.3%).[442]

HIFU has been studied for treatment of initial disease.[443,444] A prospective multi-institutional study used HIFU in 111 patients with localized prostate cancer.[443] The radical treatment-free survival rate was 89% at 2 years, and continence and erectile functions were preserved in 97% and 78% of patients, respectively, at 12 months. Morbidity was acceptable, with a grade III complication rate of 13%. In another prospective multi-institutional study, 625 men with localized prostate cancer were treated with HIFU.[445] Eighty-four percent of the cohort had intermediate- or high-risk disease. The primary endpoint of FFS was 88% at 5 years (95% CI, 85%–91%). Pad-free urinary continence was reported by 98% of participants.

HIFU also has been studied for treatment of radiation recurrence.[446-452] Analysis of a prospective registry of men treated with HIFU for radiation recurrence revealed median biochemical recurrence-free survival at 63 months, 5-year OS of 88%, and cancer-specific survival of 94%.[453] Morbidity was acceptable, with grade III/IV complication rate 3.6%. Analysis of a separate prospective registry showed that 48% of men who received HIFU following radiotherapy failure were able to avoid ADT at a median follow-up of 64 months.[454]

Other emerging local therapies, such as vascular-targeted photodynamic (VTP) therapy, warrant further study.[455] The multicenter, open-label, phase 3, randomized controlled CLIN1001 PCM301 trial compared VTP therapy (IV padeliporfin, optical fibers inserted into the prostate, and subsequent laser activation) to active surveillance in 413 men with low-risk prostate cancer.[456] After a median follow-up of 24 months, 28% of participants in the VTP arm had disease progression compared with 58% in the active surveillance arm (adjusted HR, 0.34; 95% CI, 0.24–0.46; *P* < .0001). Negative prostate biopsy results were more prevalent in the VTP group (49% vs. 14%; adjusted RR, 3.67; 95% CI, 2.53–5.33; *P* < .0001). The most common serious adverse event in the VTP group was urinary retention (3 of 206 patients), which resolved within 2 months in all cases.

## Androgen Deprivation Therapy

ADT is administered as primary systemic therapy for regional or advanced disease and as neoadjuvant/concomitant/adjuvant therapy in combination with radiation in localized or locally advanced prostate cancers.

In the community, ADT has been commonly used as primary therapy for early-stage, low-risk disease, especially in the elderly. This practice has been challenged by a large cohort study of 66,717 elderly men with T1-T2 tumors.[457] No 15-year survival benefit was found in patients receiving ADT compared to observation alone. Similarly, another cohort study of 15,170 men diagnosed with clinically localized prostate cancer who were not treated with curative intent therapy reported no survival benefit from primary ADT after adjusting for demographic and clinical variables.[458] Placing patients with early prostate cancer on ADT should not be routine practice.

Antiandrogen monotherapy (bicalutamide) after completion of primary treatment was investigated as an adjuvant therapy in patients with localized or locally advanced prostate cancer, but results did not support its use in this setting.[459,460]

Castrate levels of serum testosterone (<50 ng/dL; <1.7 nmol/L) should be achieved with ADT, because low nadir serum testosterone levels were shown to be associated with improved cause-specific survival in the PR-7 study.[461]

### ADT for Clinically Localized (N0M0) Disease

In the clinically localized setting, ADT using an LHRH agonist—alone or with a first-generation antiandrogen—or an LHRH antagonist is used as a neoadjuvant, concurrent, and/or adjuvant to EBRT, as described in more detail below.

ADT used as neoadjuvant treatment before radical prostatectomy is strongly discouraged outside of a clinical trial. Furthermore, ADT should not be used as monotherapy in clinically localized prostate cancer unless there is a contraindication to definitive local therapy, such as life expectancy <5 years and comorbidities. Under those circumstances, ADT may be an acceptable alternative if the disease is high or very high risk (see *Palliative ADT*, below).

***Neoadjuvant, Concurrent, and/or Adjuvant ADT with EBRT for Intermediate-Risk Disease***

The addition of short-term ADT to radiation improved overall and cancer-specific survival in three randomized trials containing 20% to 60% of men with intermediate-risk prostate cancer (Trans Tasman Radiation Oncology Group [TROG] 9601, Dana Farber Cancer Institute [DFCI] 95096, and Radiation Therapy Oncology Group [RTOG] 9408).[462-465] Only a cancer-specific survival benefit was noted in a fourth trial that recruited mostly high-risk men (RTOG 8610).[466] Results of the EORTC 22991 trial showed that the addition of 6 months of ADT significantly improved biochemical DFS compared with radiation alone in intermediate-risk (75% of study population) and high-risk men.[467]

RTOG 9910 and RTOG 9902 reinforced two important principles concerning the optimal duration of ADT and use of systemic chemotherapy in conjunction with EBRT.[468,469] RTOG 9910 is a phase 3 randomized trial targeting men with intermediate-risk prostate cancer that compared 4 months to 9 months of ADT. RTOG 9408 had previously shown that 4 months of ADT combined with EBRT improved survival in men with intermediate-risk disease compared to EBRT alone.[464] Consistent with earlier studies, RTOG 9910 demonstrated that there is no reason to extend ADT beyond 4 months when given in conjunction with EBRT in men with intermediate-risk disease.

RTOG 9902 compared long-term ADT and EBRT with and without paclitaxel, estramustine, and etoposide (TEE) chemotherapy in men with locally advanced, high-risk prostate cancer.[470] In the randomized cohort of 397 patients with a median follow-up of 9.2 years, results demonstrated no significant difference in ADT+EBRT versus ADT+EBRT+TEE in OS (65% vs. 63%; $P = .81$), biochemical recurrence (58% vs. 54%; $P = .82$), distant metastases (16% vs. 14%; $P = .42$), or DFS (22% vs. 26%; $P = .61$), but a substantial increase in toxicity (3.9% vs. 0% treatment-related deaths), which resulted in early closure of the trial.[470] Thus, the fact that 6 months of ADT improved survival compared to EBRT alone does not mean it is better than 4 months of ADT, and the fact that systemic chemotherapy is effective in one setting (high-volume metastatic disease or CRPC) should not lead to the assumption that it will be beneficial in other settings (eg, high-risk localized disease).[471,472]

***Neoadjuvant, Concurrent, and/or Adjuvant ADT with EBRT for High-Risk or Very-High-Risk Disease***

ADT combined with EBRT is an effective primary treatment for patients at high risk or very high risk, as discussed in the *Radiation Therapy* section, above. Combination therapy was consistently associated with improved disease-specific survival and OS compared to single-modality treatment in randomized phase 3 studies.[348,349,351,352]

Increasing evidence favors long-term over short-term neoadjuvant/concurrent/adjuvant ADT for patients with high- and very-high-risk disease. The RTOG 9202 trial included 1521 patients with T2c-T4 prostate cancer who received 4 months of ADT before and during EBRT.[473] They were randomized to no further treatment or an additional 2 years of ADT. At 10 years, the long-term group was superior for all endpoints except OS. A subgroup analysis of patients with a Gleason score of 8 to 10 found an advantage in OS for long-term ADT at 10 years (32% vs. 45%, *P* = .0061). At a median follow-up of 19.6 years, long-term ADT was superior for all endpoints including OS in the entire cohort (12% relative reduction; *P* = .03).[474]

The EORTC 22961 trial also showed superior survival when 2.5 years of ADT were added to EBRT given with 6 months of ADT in 970 patients, most of whom had T2c-T3, N0 disease.[475] The DART01/05 GICOR trial also reported similar results in men with high-risk disease.[476] In a secondary analysis of RTOG 8531, which mandated lifelong ADT for patients with locally advanced prostate cancer treated with EBRT, those who adhered to the protocol had better survival than those who discontinued ADT within 5 years.[477] Two randomized, phase 3 trials showed 1.5 years of ADT was not inferior to 3 years of ADT.[478,479]

A meta-analysis of data from 992 patients enrolled in 6 randomized controlled trials showed that a longer duration of ADT with EBRT benefited men with Grade Group 4 or 5 prostate cancer.[480]

#### Neoadjuvant, Concurrent, and/or Adjuvant ADT with EBRT for Recurrent Disease

Men who develop PSA recurrence after radical prostatectomy without evidence of metastases can receive pelvic EBRT with neoadjuvant/concurrent/adjuvant ADT (see *Adjuvant or Salvage Therapy After Radical Prostatectomy*, below).

### ADT for Regional Disease

#### Primary ADT for Lymph Node Metastases

Men initially diagnosed with node-positive disease who have a life expectancy >5 years can be treated with primary ADT. Primary ADT options are orchiectomy, an LHRH agonist, an LHRH agonist with a first-generation antiandrogen, or an LHRH antagonist (category 2B); or orchiectomy, LHRH agonist, or LHRH antagonist with abiraterone. Another option for these men is EBRT with 2 to 3 years of neoadjuvant/concurrent/adjuvant ADT (category 1, see *Neoadjuvant, Concurrent, and/or Adjuvant ADT with EBRT for Regional Disease*, below). Abiraterone acetate (abiraterone) can be added to either treatment, although abiraterone should not be coadministered with an antiandrogen (see *Abiraterone Acetate in Castration-Naïve Prostate Cancer*, below).

The EORTC 30846 trial randomized 234 treatment-naïve patients with node-positive prostate cancer to immediate versus delayed ADT.[481] At 13 years median follow-up, the authors reported similar survival between the two arms, although the study was not powered to show non-inferiority.

#### Neoadjuvant, Concurrent, and/or Adjuvant ADT with EBRT for Regional Disease

Men initially diagnosed with pelvic lymph node-positive disease who have a life expectancy >5 years can be treated with EBRT with 2 to 3 years of neoadjuvant/concurrent/adjuvant ADT (category 1) with or without abiraterone. Alternatively, they can receive primary ADT without EBRT with or without abiraterone (see *Primary ADT for Lymph Node Metastases*, above and *Abiraterone Acetate in Castration-Naïve Prostate Cancer*, below).

Neoadjuvant/concurrent/adjuvant ADT options are an LHRH agonist, an LHRH agonist with a first-generation antiandrogen, or an LHRH antagonist. Abiraterone should not be coadministered with an antiandrogen.

#### Adjuvant ADT for Lymph Node Metastases after RP

The role of adjuvant ADT after radical prostatectomy is restricted to cases where positive pelvic lymph nodes are found, although reports in this area reveal mixed findings. Messing and colleagues randomly assigned 98 patients who were found to have positive lymph nodes at the time of radical prostatectomy to immediate continuous ADT or observation.[482] In the immediate ADT arm of 47 patients, 30 remained alive, 29 of whom were prostate cancer recurrence-free and 26 of whom were PSA recurrence-free after a median follow-up of 11.9 years (range, 9.7–14.5 years for survivors).[482,483] Those receiving immediate ADT also had a significant improvement in OS (HR, 1.84; 95% CI, 1.01–3.35).

However, these results differ from a SEER Medicare, population-based test of ADT published subsequently.[484] The SEER Medicare-based study of men who underwent radical prostatectomy and had positive lymph nodes used propensity matching to compare men who received ADT within 120 days to those who were observed. The groups had similar median and range of follow-up for survivors, but OS and prostate cancer-specific survival were similar. The Messing study occurred prior to the PSA era, but the studies are similar in almost all other respects. The Messing study showed almost unbelievable benefit, and the population-based study of 731 men showed no benefit. Furthermore, a meta-analysis resulted in a recommendation against ADT for pathologic lymph node metastatic prostate cancer in the ASCO guidelines.[485] In addition, a cohort analysis of 731 men with positive nodes failed to demonstrate a survival benefit of ADT initiated within 4 months of radical prostatectomy compared to observation.[484] At this time, the panel recommends that patients with lymph node metastases found at radical prostatectomy should be considered for immediate ADT (category 1) with or without EBRT (category 2B; see *Adjuvant or Salvage Therapy After Radical Prostatectomy*, above), but that observation is also an option for these patients.

### Palliative ADT

Palliative ADT can be given to men with a life expectancy of ≤5 years who have high-risk, very-high-risk, regional, or metastatic prostate cancer. Palliative ADT also can be given to patients with disease progression during observation, usually when symptoms develop or when changes in PSA levels suggest that symptoms are imminent.

### ADT for Castration-Naive Disease

The term “castration-naive" is used to define patients who are not on ADT at the time of progression. The NCCN Prostate Cancer Panel uses the term "castration-naive" even when patients have had neoadjuvant, concurrent, and/or adjuvant ADT as part of RT provided they have recovered testicular function.

ADT for castration-naïve prostate cancer can be accomplished using bilateral orchiectomy, an LHRH agonist or antagonist, or an LHRH agonist plus a first-generation antiandrogen. As discussed below, abiraterone or docetaxel can be added to orchiectomy, LHRH agonist, or LHRH antagonist for M1 disease. For patients with M0 disease, observation is preferred over ADT.

LHRH agonists and LHRH antagonists appear equally effective in patients with advanced prostate cancer.[486] Medical or surgical castration combined with an antiandrogen is known as combined androgen blockade. No prospective randomized studies have demonstrated a survival advantage with combined androgen blockade over the serial use of an LHRH agonist and an antiandrogen.[485] Meta-analysis data suggest that bicalutamide may provide an incremental relative improvement in OS by 5% to 20% over LHRH agonist monotherapy.[487,488] However, others have concluded that more complete disruption of the androgen axis (with finasteride, dutasteride, or antiandrogen added to medical or surgical castration) provides little if any benefit over castration alone.[489]

Antiandrogen monotherapy appears to be less effective than medical or surgical castration and is not recommended for primary ADT. Furthermore, dutasteride plus bicalutamide showed no benefit over bicalutamide alone in patients with locally advanced or metastatic prostate cancer.[490]

Recent evidence suggests that orchiectomy may be safer than an LHRH agonist. Four hundred twenty-nine men with metastatic prostate cancer who underwent orchiectomy were compared to 2866 men who received LHRH agonist between 1995 and 2009. Orchiectomy was associated with lower risk of fracture, peripheral arterial disease, and cardiac-related complications, although risk was similar for diabetes, deep vein thrombosis, pulmonary embolism, and cognitive disorders.[491] Post-hoc analysis of a randomized trial of LHRH antagonist versus LHRH agonist found lower risk of cardiac events in patients with existing cardiac disease treated with LHRH antagonist.[492] The heart and T lymphocytes have receptors for LHRH. Therefore, LHRH agonists may affect cardiac contractility, vascular plaque stability, and inflammation.[493]

### *ADT for M0 Biochemical Recurrence*

Controversy remains about the timing and duration of ADT when local therapy has failed. Many believe that early ADT is best, but cancer control must be balanced against side effects. Early ADT is associated with increased side effects and the potential development of the metabolic syndrome.

Patients with an increasing PSA level and with no symptomatic or clinical evidence of cancer after definitive treatment present a therapeutic dilemma regarding the role of ADT. Some of these patients will ultimately die of their cancer. Timing of ADT for patients whose only evidence of cancer is increasing PSA is influenced by PSA velocity (PSADT), patient and physician anxiety, the short-term and long-term side effects of ADT, and underlying comorbidities of the patient. Early ADT is acceptable, but an alternative is close observation until progression of cancer, at which time appropriate therapeutic options may be considered. Earlier ADT may be better than delayed therapy, although the definitions of early and late (ie, what level of PSA) remain controversial. The multicenter phase 3 TROG 03.06/VCOG PR 01-03 [TOAD] trial randomized 293 men with PSA relapse after operation or radiation (n = 261) or who were not considered for curative treatment (n = 32) to immediate ADT or ADT delayed by a recommended interval of ≥2 years.[494] Five-year OS was improved in the immediate therapy arm compared with the delayed therapy arm (91.2% vs. 86.4%; log-rank *P* = .047). No significant differences were seen in the secondary endpoint of global health-related QOL at 2 years.[495] In addition, there were no differences over 5 years in global QOL, physical functioning, role or emotional functioning, insomnia, fatigue, dyspnea, or feeling less masculine. However, sexual activity was lower and the hormone-treatment-related symptoms score was higher in the immediate ADT group compared with the delayed ADT group. Most clinical trials in this patient population require PSA level ≥0.5 mg/dL (after radical prostatectomy) or “nadir + 2” (after radiation) for enrollment.

The panel believes that the benefit of early ADT is uncertain and must be balanced against the risk of ADT side effects. Patients with an elevated PSA and/or a shorter PSADT (rapid PSA velocity) and an otherwise long life expectancy should be encouraged to consider ADT earlier.

### *Primary ADT for M1 Castration-Naïve Prostate Cancer*

ADT is the gold standard for initial treatment of patients with metastatic disease at presentation.[485] A PSA value ≤4 ng/mL after 7 months of ADT is associated with improved survival of patients newly diagnosed with metastatic prostate cancer.[496]

ADT options for M1 castration-naïve disease are:

- Orchiectomy ± docetaxel
- LHRH agonist alone ± docetaxel
- LHRH agonist plus first-generation antiandrogen ± docetaxel
- LHRH antagonist ± docetaxel
- Orchiectomy plus abiraterone
- LHRH agonist plus abiraterone

- LHRH antagonist plus abiraterone

In patients with overt metastases in weight-bearing bone who are at risk of developing symptoms associated with the flare in testosterone with initial LHRH agonist alone, antiandrogen therapy should precede or be coadministered with LHRH agonist for at least 7 days to diminish ligand binding to the androgen receptor.[497,498] LHRH antagonists rapidly and directly inhibit the release of androgens, unlike LHRH agonists that initially stimulate LHRH receptors prior to hypogonadism. Therefore, no initial flare is associated with these agents and coadministration of antiandrogen is unnecessary.

The data supporting the addition of abiraterone or docetaxel to ADT in this setting are discussed below. ADT with addition of EBRT to the primary tumor for low-volume metastatic disease is discussed in *EBRT to the Primary Tumor in Low-Volume M1 Disease*, above.

***Abiraterone Acetate in Castration-Naïve Prostate Cancer***

In February 2018, the FDA approved abiraterone in combination with prednisone for metastatic castration-naïve prostate cancer.[499] This approval was based on 2 randomized phase 3 clinical trials of abiraterone and low-dose prednisone plus ADT that were reported in men with newly diagnosed metastatic prostate cancer or high-risk or node-positive disease (STAMPEDE and LATITUDE) that demonstrated improved OS over ADT alone.[500] In LATITUDE, 1199 men with high-risk, metastatic, castration-naïve prostate cancer were randomized to abiraterone with prednisone 5 mg once daily or matching placebos. High-risk disease was defined as at least 2 of the following: Gleason score 8–10, ≥3 bone metastases, and visceral metastases.[500] Efficacy was demonstrated at the first interim analysis, and the trial was unblinded. The primary endpoint of OS was met, and favored abiraterone (HR, 0.62; 95% CI, 0.51–0.76; $P < .0001$). Estimated 3-year OS rates improved from 49% to 66% at 30 months follow-up. Secondary endpoints were improved and included delayed castration-resistant radiographic progression (from median 14.8–33.2 months), PSA progression (7.4–33.2 months), time to pain progression, and initiation of chemotherapy.

Adverse events were higher with abiraterone and prednisone but were generally mild in nature and largely related to mineralocorticoid excess (ie, hypertension, hypokalemia, edema), hormonal effects (ie, fatigue, hot flushes), and liver toxicity.[500] Cardiac events, such as atrial fibrillation, were rare but slightly increased with abiraterone. The overall discontinuation rate due to side effects was 12%. Patient-reported outcomes were improved with the addition of abiraterone, with improvements in pain intensity progression, fatigue, functional decline, prostate cancer-related symptoms, and overall health-related QOL.[501] A limitation of this trial is that only 27% of placebo-treated men received abiraterone or enzalutamide at progression, and only 52% of these men received any life-prolonging therapy.[500]

A second randomized trial (STAMPEDE) of 1917 men with castration-naïve prostate cancer demonstrated similar OS benefits.[502] However, unlike LATITUDE, STAMPEDE eligibility permitted men with high-risk N0 M0 disease (2 of 3 high-risk factors: stage T3/4, PSA >40, or Gleason score 8–10; n = 509), or N1 M0 disease (pelvic nodal metastases; n = 369) in addition to M1 patients, who made up the majority of patients (n = 941). The majority of men were newly diagnosed, while a minority of men had recurrent, high-risk, or metastatic disease after local therapy (n = 98). Thus, STAMPEDE was a heterogeneous mix of patients with high-risk, non-metastatic, node-positive, or M1 disease. In M1 patients, treatment with abiraterone plus prednisone was continued until progression. In patients with N1 or M0 disease, 2 years of abiraterone plus prednisolone was used if curative-intent EBRT was utilized. OS was improved in the overall population (HR, 0.63; 95% CI, 0.5–0.76; $P < .0001$) and in the M1 and N1 subsets, without any heterogeneity of treatment effect by metastatic status. The survival benefit of abiraterone was larger in men <70 years of age than in older men (HR, 0.94 vs. HR, 0.51). Older men also suffered increased toxicities, which suggests heterogeneity in clinical benefits by age and comorbidity. The secondary endpoint of FFS, which included PSA recurrence, was improved overall (HR, 0.29; *P* < .0001) and in all subgroups regardless of M1 (HR, 0.31), N1 (HR, 0.29), or M0 (HR, 0.21) status. No heterogeneity for FFS was observed based on subgroups or by age. In this trial, subsequent life-prolonging therapy was received by 58% of men in the control group, which included 22% who received abiraterone and 26% who received enzalutamide. Thus, these data reflect a survival advantage of initial abiraterone in newly diagnosed men compared with deferring therapy to the CRPC setting.

Adverse events in STAMPEDE were similar to that reported in LATITUDE, but were increased in older men, with higher incidences of grade 3–5 adverse events with abiraterone (47% vs. 33%) and 9 versus 3 treatment-related deaths. Severe hypertension or cardiac disorders were noted in 10% of men and grade 3–5 liver toxicity in 7%, which illustrates the need for blood pressure and renal and hepatic function monitoring.

Taken together, these data led the NCCN Panel to recommend abiraterone with 5-mg once-daily prednisone as a treatment option with ADT for men with newly diagnosed, M1, castration-naïve prostate cancer (category 1). Alternatively, the fine-particle formulation of abiraterone can be used (category 2B; see *Abiraterone Acetate in M1 CRPC*, below). For men undergoing curative-intent treatment for N1 disease, abiraterone can be added to EBRT with 2 to 3 years of neoadjuvant/concurrent/adjuvant ADT or can be given with ADT for castration-naïve disease (without EBRT). The fine-particle formulation of abiraterone is an option (category 2B; see *Abiraterone Acetate in M1 CRPC*, below). However, there was insufficient survival, FFS data, and follow-up available to recommend abiraterone for men with high-risk or very-high-risk N0 M0 prostate cancer. Further follow-up and dedicated ongoing clinical trials are needed in this curative-intent RT population.

Abiraterone with prednisone can be given at 250 mg/d and administered following a low-fat breakfast, as an alternative to the dose of 1000 mg/d after an overnight fast (see *Abiraterone Acetate in M1 CRPC*, below).[503] The cost savings may reduce financial toxicity and improve compliance.

### *Apalutamide in Castration-Naïve Prostate Cancer*

The double-blind phase 3 TITAN clinical trial randomized 1052 patients with metastatic, castration-naïve prostate cancer to ADT with apalutamide (240 mg/day) or placebo.[504] Participants were stratified by Gleason score at diagnosis, geographic region, and previous docetaxel treatment. The median follow-up was 22.7 mo. Both primary endpoints were met: radiographic PFS (68.2% vs. 47.5% at 24 mo; HR for radiographic progression or death, 0.48; 95% CI, 0.39-0.60; *P* < .001) and OS (82.4% vs. 73.5% at 24 mo; HR for death, 0.67; 95% CI, 0.51-0.89; *P* = .005). Adverse events that were more common with apalutamide than with placebo included rash, hypothyroidism, and ischemic heart disease.

Apalutamide is a category 1 option for patients with M1 castration-naïve prostate cancer.

### *Enzalutamide in Castration-Naïve Prostate Cancer*

The open-label randomized phase 3 ENZAMET clinical trial compared enzalutamide (160 mg/day) plus ADT with ADT alone in 1125 men with metastatic castration-naïve prostate cancer.[505] Stratification was by volume of disease, planned use of early docetaxel, planned use of bone anti-resorptive therapy, comorbidity score, and trial site. The primary endpoint of OS was met at the first interim analysis with median follow-up 34 months (HR for death, 0.67; 95% CI, 0.52-0.86; *P* = .002). Enzalutamide also improved secondary endpoints, such as PFS using PSA levels and clinical PFS.

In the double-blind randomized phase 3 ARCHES clinical, 1150 men with metastatic castration-naïve prostate cancer were randomized to receive ADT with either enzalutamide (160 mg/day) or placebo. Participants were stratified by disease volume and prior docetaxel use. The primary endpoint was radiographic PFS, which was improved in the enzalutamide group after median follow-up 14.4 mo (19.0 mo vs. not reached; HR, 0.39; 95% CI, 0.30-0.50; *P* < .001).[506]

The safety of enzalutamide in these trials was similar to that seen in previous trials in the castration-resistant setting. Adverse events associated with enzalutamide in these trials included fatigue, seizures, and hypertension.[505,506]

Enzalutamide is a category 1 option for patients with M1 castration-naïve prostate cancer.

### Intermittent Versus Continuous ADT (Non-Metastatic)

ADT is associated with substantial side effects, which generally increase with the duration of treatment. Intermittent ADT is an approach based on the premise that cycles of androgen deprivation followed by re-exposure may delay "androgen independence," reduce treatment morbidity, and improve QOL.[507,508]

The Canadian-led PR.7 trial was a phase 3 trial of intermittent versus continuous ADT in patients with non-metastatic prostate cancer who experienced biochemical recurrence after primary or salvage EBRT.[509] One thousand three hundred eighty-six patients with PSA >3 ng/mL were randomly assigned to intermittent ADT or continuous ADT. At a median follow-up of 6.9 years, the intermittent approach was non-inferior to continuous ADT with respect to OS (8.8 vs. 9.1 years, respectively; HR, 1.02; 95% CI, 0.86–1.21). More patients died from prostate cancer in the intermittent ADT arm (120 of 690 patients) than in the continuous ADT arm (94 of 696 patients), but this was balanced by more non-prostate cancer deaths in the continuous ADT arm. Physical function, fatigue, urinary problems, hot flashes, libido, and erectile dysfunction showed modest improvement in the intermittent ADT group. The test population was heterogenous, so it remains unclear which of these asymptomatic patients benefitted from treatment. It is possible that many of these patients could have delayed ADT without harm. The test population had a low disease burden and 59% of deaths in the trial were not related to prostate cancer. Follow-up longer than 6.9 years may be required for disease-specific deaths to out-balance deaths by other causes.

An unplanned Cox regression analysis of the trial showed that men with Gleason sum >7 in the continuous ADT arm had a median survival (8 years) that was 14 months longer than those with the same Gleason sum in the intermittent ADT arm (6.8 years).[509] In this situation, patients should be given the option to weigh the effects of ADT on QOL against a possible impact on survival, although pathology was not centrally reviewed and the study was not powered to detect small differences in survival based on Gleason sum.[510]

The multinational European ICELAND trial randomized 702 participants with locally advanced or biochemically recurrent prostate cancer to continuous or intermittent ADT.[511] Clinical outcomes, which included time to PSA progression, PSA progression-free survival, OS, mean PSA levels over time, QOL, and adverse events, were similar between the arms.

A 2015 meta-analysis identified 6 randomized controlled trials comparing continuous with intermittent ADT in men with locally advanced prostate cancer and found no difference in mortality and progression and an advantage of the intermittent approach in terms of QOL and adverse effects.[512]

### Intermittent Versus Continuous ADT (Metastatic)

Hussain and colleagues[513] conducted the SWOG (Southwest Oncology Group) 9346 trial to compare intermittent and continuous ADT in patients with metastatic disease. After 7 months of induction ADT, 1535 patients whose PSA dropped to 4 ng/mL or below (thereby demonstrating androgen sensitivity) were randomized to intermittent or continuous ADT. At a median follow-up of 9.8 years, median survival was 5.1 years for the intermittent ADT arm and 5.8 years for the continuous ADT arm. The HR for death with intermittent ADT was 1.10 with a 90% CI between 0.99 and 1.23, which exceeded the pre-specified upper boundary of 1.20 for non-inferiority. The authors stated that the survival results were inconclusive, and that a 20% greater mortality risk with the intermittent approach cannot be ruled out. The study demonstrated better erectile function and mental health in patients receiving intermittent ADT at 3 months, but the difference became insignificant thereafter, most likely due to contamination of assessments of those on the intermittent arm who may have returned to ADT at the pre-specified time points. A secondary analysis of SWOG 9346 showed that intermittent ADT did not reduce endocrine, bone, or cognitive events, whereas it increased the incidence of ischemic and thrombotic events.[514]

In a post-hoc stratification analysis of the trial, patients with minimal disease had a median survival of 5.4 years when receiving intermittent ADT versus 6.9 years when receiving continuous ADT (HR, 1.19; 95% CI, 0.98–1.43).[513] The median survival was 4.9 years in the intermittent ADT arm compared to 4.4 years in the continuous ADT arm for patients with extensive disease (HR, 1.02; 95% CI, 0.85–1.22). These subgroup analyses are hypothesis-generating.

A population-based analysis that included 9772 patients with advanced prostate cancer aged ≥66 years showed that intermittent ADT reduced the risks of total serious cardiovascular events by 36%, heart failure by 38%, and pathologic fracture by 48%, compared with continuous ADT.[515] Furthermore, several meta-analyses of randomized controlled trials reported no difference in survival between intermittent ADT and continuous ADT.[516-518] Another recent analysis concluded that the non-inferiority of intermittent to continuous ADT in terms of survival has not been clearly demonstrated.[519] Still, the intermittent approach leads to marked improvement in QOL compared to the continuous approach in most studies, and the panel believes that intermittent ADT should be strongly considered.

A more personalized approach could be to treat all patients with metastatic disease with ADT. After 7 months of ADT, patients can be assigned a risk category based on the PSA value at that time point[496]: low risk is defined by a PSA less than 0.2 ng/mL (median survival of 75 months); intermediate risk is defined by a PSA between 0.2 and 4.0 ng/mL (median survival of 44 months), and high risk is defined by a PSA higher than 4.0 ng/mL (median survival of 13 months). Those patients who have few or no symptoms related to ADT after 7 months of therapy will not benefit from intermittent ADT in terms of QOL, and therefore continuous is reasonable because it is easier to administer.[510] However, for those patients with significant side effects impacting QOL, intermittent ADT should be considered for those with low or intermediate risk after a discussion about the impact on survival. A final consideration is based on a subgroup analysis of S9346 that suggested that those who initially present with pain have better survival on continuous therapy than intermittent therapy.

### Adverse Effects of Traditional ADT

ADT has a variety of adverse effects including hot flashes, vasomotor instability, osteoporosis, greater incidence of clinical fractures, obesity, insulin resistance, alterations in lipids, and greater risk for diabetes, acute kidney injury, and cardiovascular disease.[520-522] Recent evidence suggests that a link between ADT and cognitive decline or future Alzheimer's disease may exist, although data are inconsistent, the risk is low, and the link remains to be proven.[523-527] In general, the side effects of continuous ADT increase with the duration of treatment. Patients and their medical providers should be advised about these risks prior to treatment.

***Bone Health During ADT***

ADT is associated with greater risk for clinical fractures. In large population-based studies, for example, ADT was associated with a 21% to 54% relative increase in fracture risk.[528-530] Longer treatment duration conferred greater fracture risk. Age and comorbidity also were associated with higher fracture incidence. In a population-based cohort of 3295 patients, surgical castration was associated with a significantly lower risk of fractures than medical castration using a GnRH agonist (HR, 0.77; 95% CI, 0.62–0.94; *P* = .01).[493] ADT increases bone turnover and decreases bone mineral density,[531-534] a surrogate for fracture risk in patients with non-metastatic disease. Bone mineral density of the hip and spine decreases by approximately 2% to 3% per year during initial therapy. Most studies have reported that bone mineral density continues to decline steadily during long-term therapy. ADT significantly decreases muscle mass,[535] and treatment-related sarcopenia appears to contribute to frailty and increased risk of falls in older men.

The NCCN Guidelines Panel recommends screening and treatment for osteoporosis according to guidelines for the general population from the National Osteoporosis Foundation.[536] The National Osteoporosis Foundation guidelines include: 1) calcium (1000–1200 mg daily from food and supplements) and vitamin D3 (400–1000 IU daily); and 2) additional treatment for men aged ≥50 years with low bone mass (T-score between -1.0 and -2.5, osteopenia) at the femoral neck, total hip, or lumbar spine by dual-energy x-ray absorptiometry (DEXA) scan and a 10-year probability of hip fracture ≥3% or a 10-year probability of a major osteoporosis-related fracture ≥20%. Fracture risk can be assessed using the algorithm FRAX®, recently released by WHO.[537] ADT should be considered "secondary osteoporosis" using the FRAX® algorithm.

Earlier randomized controlled trials demonstrated that bisphosphonates increase bone mineral density, a surrogate for fracture risk, during ADT.[538-540] In 2011, the FDA approved denosumab as a treatment to prevent bone loss and fractures during ADT. Denosumab binds to and inhibits the receptor activator of NF-κB ligand (RANKL) to blunt osteoclast function and delay generalized bone resorption and local bone destruction. Approval was based on a phase 3 study that randomized 1468 patients with non-metastatic prostate cancer undergoing ADT to either biannual denosumab or placebo. At 24 months, denosumab increased bone mineral density by 6.7% and reduced fractures (1.5% vs. 3.9%) compared to placebo.[541] Denosumab also was approved for prevention of SREs in patients with bone metastasis (see *Chemotherapy and Immunotherapy*).

Currently, treatment with denosumab (60 mg every 6 months), zoledronic acid (5 mg IV annually), or alendronate (70 mg PO weekly) is recommended when the absolute fracture risk warrants drug therapy. A baseline DEXA scan before start of therapy and a follow-up DEXA scan after one year of therapy is recommended by the International Society for Clinical Densitometry to monitor response. Use of biochemical markers of bone turnover is not recommended. There are no existing guidelines on the optimal frequency of vitamin D testing, but vitamin D levels can be measured when DEXA scans are obtained.

***Diabetes and Cardiovascular Disease***

In a landmark population-based study, ADT was associated with higher incidence of diabetes and cardiovascular disease.[542] After controlling for other variables, which included age and comorbidity, ADT with a GnRH agonist was associated with increased risk for new diabetes (HR, 1.44; *P* < .001), coronary artery disease (HR, 1.16; *P* < .001), and myocardial infarction (HR, 1.11; *P* = .03). Studies that evaluated the potential relationship between ADT and cardiovascular mortality have produced mixed results.[466,542-549] In a Danish cohort of 31,571 patients with prostate cancer, medical castration was associated with an increased risk for myocardial infarction (HR, 1.31; 95% CI, 1.16–1.49) and stroke (HR, 1.19; 95% CI, 1.06–1.35) whereas surgical castration was not.[550] Other population-based studies resulted in similar findings.[493,551] However, a Taiwan National Health Insurance Research Database analysis found no difference in ischemic events with LHRH agonist therapy or orchiectomy.[552] A French database study showed the cardiovascular risk to be similar in men taking LHRH agonists and antagonists.[553] However, some data suggest that LHRH antagonists might be associated with a lower risk of cardiac events within 1 year in men with preexisting cardiovascular disease (history of myocardial ischemia, coronary artery disease, myocardial infarction, cerebrovascular accident, angina pectoris, or coronary artery bypass) compared with agonists.[492] Men with a recent history of cardiovascular disease appear to have higher risk,[554] and increased physical activity may decrease the symptoms and cardiovascular side effects of men treated with ADT.[555]

Several mechanisms may contribute to greater risk for diabetes and cardiovascular disease during ADT. ADT increases fat mass and decreases lean body mass.[535,556,557] ADT with a GnRH agonist increases fasting plasma insulin levels[558,559] and decreases insulin sensitivity.[560] ADT also increases serum levels of cholesterol and triglycerides.[558,561]

Cardiovascular disease and diabetes are leading causes of morbidity and mortality in the general population. Based on the observed adverse metabolic effects of ADT and the association between ADT and higher incidence of diabetes and cardiovascular disease, screening for and intervention to prevent/treat diabetes and cardiovascular disease are recommended for men receiving ADT. Whether strategies for screening, prevention, and treatment of diabetes and cardiovascular disease in men receiving ADT should differ from those of the general population remains uncertain.

## Secondary Hormone Therapy for CRPC

Most men with advanced disease eventually stop responding to traditional ADT and are categorized as castration-resistant (also known as castration-recurrent). Research has shown enhancement of autocrine and/or paracrine androgen synthesis in the tumor microenvironment of men receiving ADT.[562,563] Androgen signaling consequent to non-gonadal sources of androgen in CRPC refutes earlier beliefs that CRPC was resistant to further hormone therapies. The development of novel hormonal agents demonstrating efficacy in the metastatic CRPC setting dramatically changed the paradigm of CRPC treatment.

For men who develop CRPC, ADT with an LHRH agonist or antagonist should be continued to maintain castrate serum levels of testosterone (<50 ng/dL). Options for secondary hormone therapy include a first-generation antiandrogen, antiandrogen withdrawal, ketoconazole (adrenal enzyme inhibitor) with or without hydrocortisone, corticosteroid, diethylstilbestrol (DES), or other estrogen.[564,565] However, none of these strategies has yet been shown to prolong survival in randomized clinical trials. New secondary hormone options include abiraterone (M1 only), enzalutamide (M0 or M1), and apalutamide (M0 only), as discussed below.

DES can produce safe chemical castration in many men. Gynecomastia and cardiovascular side effects occur with increasing frequency with increasing dose. Side effects are rare, and survival appears equivalent to that of other means of ADT at a 1-mg daily dose. The mechanism of action of DES remains uncertain because a 1-mg dose does not render some men castrate, and DES produces responses when used in CRPC.[566]

Transdermal estradiol may provide similar cancer control with fewer side effects.[567] The ongoing PATCH clinical trial demonstrated similar rates of castrate levels of testosterone, PSA response, and side effects in 85 men treated with LHRH agonist and 168 men treated with 100 mcg/24 hours estrogen patches twice weekly.[568] QOL outcomes and the experience of vasomotor symptoms were better at 6 months in the transdermal group compared with the agonist group, but rates of significant gynecomastia were higher in the transdermal group (37% vs. 5%).[569] The PATCH trial continues enrollment in order to assess survival (NCT00303784).

### Abiraterone Acetate in M1 CRPC

In April 2011, the FDA approved the androgen synthesis inhibitor, abiraterone, in combination with low-dose prednisone, for the treatment of men with metastatic CRPC who have received prior chemotherapy containing docetaxel.

FDA approval in the post-docetaxel setting was based on the results of a phase 3, randomized, placebo-controlled trial (COU-AA-301) in men with metastatic CRPC previously treated with docetaxel-containing regimens.[570,571] Patients were randomized to receive either abiraterone 1000 mg orally once daily (n = 797) or placebo once daily (n = 398), and both arms received daily prednisone. In the final analysis, median survival was 15.8 vs. 11.2 months in the abiraterone and placebo arm, respectively (HR, 0.74; 95% CI, 0.64–0.86; *P* < .0001).[571] Time to radiographic progression, PSA decline, and pain palliation also were improved by abiraterone.[571,572]

FDA approval in the pre-docetaxel setting occurred on December 10, 2012, and was based on the randomized phase 3 COU-AA-302 trial of abiraterone and prednisone (n = 546) versus prednisone alone (n = 542) in men with asymptomatic or minimally symptomatic, metastatic CRPC.[573] Most men in this trial were not taking narcotics for cancer pain and none had visceral metastatic disease or prior ketoconazole exposure. The coprimary endpoint of radiographic progression-free survival was improved by treatment from 8.3 to 16.5 months (HR, 0.53; *P* < .001). OS was improved at final analysis with a median follow-up of 49.2 months (34.7 months vs. 30.3 months; HR, 0.81; 95% CI, 0.70–0.93; *P* = .003).[574] Key secondary endpoints of time to symptomatic deterioration, time to chemotherapy initiation, time to pain progression, and PSA progression-free survival improved significantly with abiraterone treatment, and PSA declines (62% vs. 24% with >50% decline) and radiographic responses (36% vs. 16% RECIST responses) were more common.

The most common adverse reactions with abiraterone/prednisone (>5%) were fatigue (39%); back or joint discomfort (28%–32%); peripheral edema (28%); diarrhea, nausea, or constipation (22%); hypokalemia (17%); hypophosphatemia (24%); atrial fibrillation (4%); muscle discomfort (14%); hot flushes (22%); urinary tract infection; cough; hypertension (22%, severe hypertension in 4%); urinary frequency and nocturia; dyspepsia; or upper respiratory tract infection. The most common adverse drug reactions that resulted in drug discontinuation were increased aspartate aminotransferase and/or alanine aminotransferase (11%–12%), or cardiac disorders (19%, serious in 6%).

In May 2018, the FDA approved a novel, fine-particle formulation of abiraterone, in combination with methylprednisolone, for the treatment of patients with metastatic CRPC.[575] In studies of healthy men, this formulation at 500 mg was shown to be bioequivalent to 1000 mg of the originator formulation.[576,577] In a phase 2 therapeutic equivalence study, 53 men with metastatic CRPC who were not treated previously with abiraterone, enzalutamide, radium-223, or chemotherapy (docetaxel for metastatic CRPC completed ≥1 year prior to enrollment was allowed) were randomized to 500 mg daily of the new formulation plus 4 mg methylprednisolone orally twice daily or to 1000 mg of the originator formulation daily plus 5 mg prednisone orally twice daily.[578] Bioequivalence of these doses was confirmed based on serum testosterone levels, PSA response, and abiraterone pharmacokinetics. The rates of total and grade 3/4 adverse events were similar between the arms, with musculoskeletal and connective tissue disorders occurring more frequently in the originator-treated patients (37.9% vs. 12.5%). The panel believes that the fine-particle formulation of abiraterone can be used instead of the original formulation of abiraterone in the treatment of men with metastatic CRPC (category 2A), but switching from one formulation to the other upon disease progression should not be undertaken. Abiraterone with either steroid should not be given following progression on abiraterone with the other steroid.

Abiraterone should be given with concurrent steroid (either oral prednisone 5 mg twice daily or oral methylprednisolone 4 mg twice daily, depending on which formulation is given) to abrogate signs of mineralocorticoid excess that can result from treatment. These signs include hypertension, hypokalemia, and peripheral edema. Thus, monitoring of liver function, potassium and phosphate levels, and blood pressure readings on a monthly basis, at least initially is warranted during abiraterone therapy. Some patients may be able to avoid steroids with abiraterone, but careful monitoring is warranted, and a mineralocorticoid receptor antagonist or steroid should be added to control side effects if necessary.[579-581] Symptom-directed assessment for cardiac disease also is warranted, particularly in patients with pre-existing cardiovascular disease.

A randomized phase 2 non-inferiority study of 75 patients with M1 CRPC compared 1000 mg/d abiraterone with prednisone after an overnight fast with 250 mg/d after a low-fat breakfast.[503] The primary endpoint was log change in PSA, with secondary endpoints of PSA response (≥ 50%) and progression-free survival. The primary endpoint favored the low-dose arm (log change in PSA, -1.59 vs. -1.19), as did the PSA response rate (58% vs. 50%), with an equal progression-free survival of 9 months in both arms. Noninferiority of the low dose was established according to the predefined criteria. Therefore, abiraterone with prednisone can be given at 250 mg/d administered following a low-fat breakfast, as an alternative to the dose of 1000 mg/d after an overnight fast. The cost savings may reduce financial toxicity and improve compliance. Food impacts absorption unpredictably; side effects should be monitored and standard dosing (1000 mg on empty stomach) utilized if excess toxicity is observed on modified dosing (250 mg with food).

### Enzalutamide in M0 and M1 CRPC

On August 31, 2012, the FDA approved enzalutamide, a next-generation antiandrogen, for treatment of men with metastatic CRPC who had received prior docetaxel chemotherapy. Approval was based on the results of the randomized, phase 3, placebo-controlled trial (AFFIRM).[582,583] AFFIRM randomized 1199 men to enzalutamide or placebo in a 2:1 ratio and the primary endpoint was OS. Median survival was improved with enzalutamide from 13.6 to 18.4 months (HR, 0.63; *P* < .001). Survival was improved in all subgroups analyzed. Secondary endpoints also were improved significantly, which included the proportion of men with >50% PSA decline (54% vs. 2%), radiographic response (29% vs. 4%), radiographic progression-free survival (8.3 vs. 2.9 months), and time to first SRE (16.7 vs. 13.3 months). QOL measured using validated surveys was improved with enzalutamide compared to placebo. Adverse events were mild, and included fatigue (34% vs. 29%), diarrhea (21% vs. 18%), hot flushes (20% vs. 10%), headache (12% vs. 6%), and seizures (0.6% vs. 0%). The incidence of cardiac disorders did not differ between the arms. Enzalutamide is dosed at 160 mg daily. Patients in the AFFIRM study were maintained on GnRH agonist/antagonist therapy and could receive bone supportive care medications. The seizure risk in the enzalutamide FDA label was 0.9% versus 0.6% in the manuscript.[582,584]

Another phase 3 trial studied enzalutamide in the pre-chemotherapy setting. The PREVAIL study randomly assigned 1717 patients with chemotherapy-naïve metastatic prostate cancer to daily enzalutamide or placebo.[585,586] The study was stopped early due to benefits shown in the treatment arm. Compared to the placebo group, the enzalutamide group showed improved median progression-free survival (20.0 months vs. 5.4 months) and median OS (35.3 months vs. 31.3 months). Improvements in all secondary endpoints were also observed (eg, the time until chemotherapy initiation or first SRE).

Two randomized clinical trials have reported that enzalutamide may be superior to bicalutamide for cancer control in metastatic CRPC. The TERRAIN study randomized 375 men with treatment-naïve, metastatic CRPC to 160 mg/d enzalutamide or 50 mg/d bicalutamide in a 1:1 manner.[587] The enzalutamide group had significantly better progression-free survival (defined as PSA progression, soft tissue progression, or development of additional bony metastases) compared to the bicalutamide group (median time to progression, 15.7 vs. 5.8 months; HR, 0.44; 95% CI, 0.34–0.57).

The STRIVE trial randomized 396 men with M0 or M1 treatment-naïve CRPC to 160 mg/d enzalutamide or 50 mg/d bicalutamide in a 1:1 manner.[588] The primary endpoint in this study was progression-free survival, defined as either PSA progression, radiographic progression of disease, or death from any cause. Enzalutamide reduced the risk of progression or death by 76% compared to bicalutamide (HR, 0.24; 95% CI, 0.18–0.32). These studies demonstrated that enzalutamide extended progression-free survival better than bicalutamide in men choosing an antiandrogen for secondary hormonal therapy treatment of CRPC. Bicalutamide can still be considered in some patients, given the different side-effect profiles of the agents and the increased cost of enzalutamide.

Thus, enzalutamide represents a treatment option for men in both the pre-docetaxel and post-docetaxel metastatic CRPC setting and is a reasonable choice for men who are not candidates for chemotherapy. Patients receiving enzalutamide have no restrictions for food intake and concurrent prednisone is permitted but not required.[582]

The randomized, double-blind, placebo-controlled phase 3 PROSPER trial assessed the use of enzalutamide in 1401 men with non-metastatic CRPC.[589] Men with PSADT ≤10 months were stratified according to PSADT (<6 months vs. ≥6 months) and use of bone-sparing agents and randomized 2:1 to enzalutamide (160 mg/d) plus ADT or placebo plus ADT. Enzalutamide improved the primary endpoint of metastasis-free survival over placebo (36.6 months vs. 14.7 months; HR for metastasis or death, 0.29; 95% CI, 0.24–0.35; $P < .0001$). No significant difference was seen in OS, although OS data were not mature at the time of final analysis for metastasis-free survival. Adverse events included fatigue (33% vs. 14%), hypertension (12% vs. 5%), major adverse cardiovascular events (5% vs. 3%), and mental impairment disorders (5% vs. 2%). Patient-reported outcomes from PROSPER indicate that enzalutamide delayed pain progression, symptom worsening, and decrease in functional status, compared with placebo.[590] The FDA expanded approval for enzalutamide to include men with non-metastatic CRPC on July 13, 2018,[584] and the panel believes that patients with M0 CRPC can be offered enzalutamide, if PSADT is ≤10 months (category 1).

### Apalutamide in M0 CRPC

The FDA approved apalutamide for treatment of patients with non-metastatic CRPC on February 14, 2018.[591] This approval was based on the phase 3 SPARTAN trial of 1207 patients with M0 CRPC and PSADT ≤10 months.[592] Participants were stratified according to PSADT (>6 months vs. ≤6 months), use of bone-sparing agents, and the presence of metastatic pelvic lymph nodes (N0 vs. N1). After median follow-up of 20.3 months, apalutamide at 240 mg/d with ADT improved the primary endpoint of metastasis-free survival over placebo with ADT (40.5 months vs. 16.2 months; HR for metastasis or death, 0.28; 95% CI, 0.23–0.35; $P < .001$).

No significant difference was seen in OS, although OS data were not mature at the time of final analysis for metastasis-free survival. Adverse events included rash (24% vs. 5.5%), fracture (11% vs. 6.5%), and hypothyroidism (8% vs. 2%). Patients with M0 CRPC can be offered apalutamide, if PSADT is ≤10 months (category 1). In a prespecified exploratory analysis of SPARTAN, health-related QOL was maintained in both the apalutamide and placebo groups.[593]

### Darolutamide in M0 CRPC

The FDA approved darolutamide for treatment of patients with non-metastatic CRPC on July 30, 2019.[594] The phase 3 ARAMIS study randomized 1509 patients with M0 CRPC and PSADT ≤10 mo 2:1 to darolutamide (600 mg twice daily) or placebo.[595] Participants were stratified according to PSADT (>6 months vs. ≤6 months) and the use of osteoclast-targeted agents. The median follow-up time was 17.9 mo. Darolutamide improved the primary endpoint of metastasis-free survival compared to placebo (40.4 mo vs. 18.4 mo; HR for metastasis or death, 0.41; 95% CI, 0.34–0.50; *P* < .001). An improvement in overall survival was observed at the first interim analysis (HR for death, 0.71; 95% CI, 0.50-0.99; *P* = .045), although these data are immature (median survival was not reached in either arm). Adverse events that occurred more frequently in the treatment arm included fatigue (12.1% vs. 8.7%), pain in an extremity (5.8% vs. 3.2%), and rash (2.9% vs. 0.9%). The incidence of fractures was similar between darolutamide and placebo (4.2% vs. 3.6%).

Darolutamide is a category 1 option for patients with M0 CRPC if PSADT is ≤10 months.

## Chemotherapy and Immunotherapy

Recent research has expanded the therapeutic options for patients with metastatic CRPC depending on the presence or absence of symptoms.

### Docetaxel

Two randomized phase 3 studies evaluated docetaxel-based regimens in symptomatic or rapidly progressive disease (TAX 327 and SWOG 9916).[472,596,597] TAX 327 compared docetaxel (every 3 weeks or weekly) plus prednisone to mitoxantrone plus prednisone in 1006 men.[596] Every-3-week docetaxel resulted in higher median OS than mitoxantrone (18.9 vs. 16.5 months; *P* = .009). This survival benefit was maintained at extended follow-up.[597] The SWOG 9916 study also showed improved survival with docetaxel when combined with estramustine compared to mitoxantrone plus prednisone.[472] Docetaxel is FDA-approved for metastatic CRPC. The standard regimen is every 3 weeks. An alternative to every-3-week docetaxel is a biweekly regimen of 50 mg/m$^2$. This regimen is based on a large randomized phase 2 trial of 346 men with metastatic CRPC randomized to either every-2-week docetaxel or every-3-week docetaxel, each with maintenance of ADT and prednisone.[598] Men treated with the every-2-week regimen survived an average of 19.5 months compared to 17.0 months with the every-3-week regimen (*P* = .015). Time-to-progression and PSA decline rate favored every-2-week therapy. Tolerability was improved with every-2-week docetaxel; febrile neutropenia rate was 4% versus 14% and other toxicities and overall QOL were similar.

Docetaxel is included as an upfront option for men with castration-naïve prostate cancer and distant metastases based on results from two phase 3 trials (ECOG 3805/CHAARTED and STAMPEDE).[599,600] CHAARTED randomized 790 men with metastatic, castration-naïve prostate cancer to docetaxel (75 mg/m$^2$ IV q3 weeks x 6 doses) plus ADT or ADT alone.[600] After a median follow-up of 53.7 months, the patients in the combination arm experienced a longer OS than those in the ADT arm (57.6 months vs. 47.2 months; HR, 0.72; 95% CI, 0.59–0.89; *P* = .002).[601] Subgroup analysis showed that the survival benefit was more pronounced in the 65% of participants with high-volume disease (HR, 0.63; 95% CI, 0.50–

0.79; *P* < .001). Men with low-volume disease in CHAARTED did not derive a survival benefit from the inclusion of docetaxel (HR, 1.04; 95% CI, 0.70–1.55; *P* = .86).

The STAMPEDE trial, a multi-arm, multi-stage phase 3 trial, included patients with both M0 and M1 castration-naïve prostate cancer.[599] The results in the M1 population essentially confirmed the survival advantage of adding docetaxel (75 mg/m$^2$ IV q3 weeks x 6 doses) to ADT seen in the CHAARTED trial. In STAMPEDE, extent of disease was not evaluated in the 1087 men with metastatic disease, but the median OS for all patients with M1 disease was 5.4 years in the ADT-plus-docetaxel arm versus 3.6 years in the ADT-only arm (a difference of 1.8 years between groups compared with a 1.1-year difference in CHAARTED). The results of the STAMPEDE trial seem to confirm the results of the CHAARTED trial.

Some data suggest that the use of docetaxel in combination with ADT and EBRT may benefit fit men with high- and very-high-risk localized disease. The GETUG 12 trial, which randomized 413 men with high- or very-high risk prostate cancer to IMRT and ADT or ADT, docetaxel, and estramustine.[602] After a median follow-up of 8.8 years, 8-year relapse-free survival was 62% in the combination therapy arm and 50% in the ADT-only arm (adjusted HR, 0.71; 95% CI, 0.54–0.94; *P* = .017). The multicenter, phase 3 NRG Oncology RTOG 0521 trial randomized 563 patients with high- or very-high-risk prostate cancer ADT plus EBRT with or without docetaxel.[603] After median follow-up of 5.7 years, 4-year OS was 89% (95% CI, 84%–92%) for ADT/EBRT and 93% (95% CI, 90%–96%) for ADT/EBRT/docetaxel (HR, 0.69; 90% CI, 0.49–0.97; one-sided *P* = .03). Improvements were also seen in DFS and the rate of distant metastasis. The panel does not recommended the addition of docetaxel to ADT plus EBRT in patients with high and very-high-risk prostate cancer, however, at this time. Longer follow-up is needed to determine the effects of early docetaxel on response to subsequent treatment. In addition, longer follow-up will show whether the long-term side effects of EBRT, which generally begin 4 to 5 years after EBRT, are increased with docetaxel.

### Cabazitaxel

In June 2010, the FDA approved cabazitaxel, a semi-synthetic taxane derivative, for men with metastatic CRPC previously treated with a docetaxel-containing regimen. An international randomized phase 3 trial (TROPIC) randomized 755 men with progressive metastatic CRPC to receive cabazitaxel 25 mg/m$^2$ or mitoxantrone 12 mg/m$^2$, each with daily prednisone.[604] A 2.4-month improvement in OS was demonstrated with cabazitaxel compared to mitoxantrone (HR, 0.72; *P* < .0001). The improvement in survival was balanced against a higher toxic death rate with cabazitaxel (4.9% vs. 1.9%), which was due, in large part, to differences in rates of sepsis and renal failure. Febrile neutropenia was observed in 7.5% of cabazitaxel-treated men versus 1.3% of mitoxantrone-treated men. The incidences of severe diarrhea (6%), fatigue (5%), nausea/vomiting (2%), anemia (11%), and thrombocytopenia (4%) also were higher in cabazitaxel-treated men, which indicated the need for vigilance and treatment or prophylaxis in this setting to prevent febrile neutropenia. The survival benefit was sustained at an updated analysis with a median follow-up of 25.5 months.[605] Furthermore, results of a post-hoc analysis of this trial suggested that the occurrence of grade ≥3 neutropenia after cabazitaxel treatment was associated with improvements in both progression-free survival and OS.[606]

The phase 3 open-label, multinational, non-inferiority PROSELICA study compared 20 mg/m$^2$ cabazitaxel with 25 mg/m$^2$ cabazitaxel in 1,200 patients with metastatic CRPC who progressed on docetaxel.[607] The lower dose was found to be noninferior to the higher dose for median OS (13.4 months [95% CI, 12.19–14.88] vs. 14.5 months [95% CI, 13.47–15.28]), and grade 3/4 adverse events were decreased (39.7% vs. 54.5%). In particular, grade ≥3 neutropenia rates were 41.8% and 73.3% for the lower and higher dose groups, respectively. Cabazitaxel at 20 mg/m$^2$ every 3 weeks, with or without growth factor support, is now standard of care for fit patients. Cabazitaxel at 25 mg/m$^2$ may be considered for healthy men who wish to be more aggressive.

Recent results from the phase 3 FIRSTANA study suggested that cabazitaxel has clinical activity in patients with chemotherapy-naïve mCRPC.[608] Median OS, the primary endpoint, was similar between 20 mg/m$^2$ cabazitaxel, 25 mg/m$^2$ cabazitaxel, and 75 mg/m$^2$ docetaxel (24.5 months, 25.2 months, and 24.3 months, respectively). Cabazitaxel was associated with lower rates of peripheral sensory neuropathy than docetaxel, particularly at 20 mg/m$^2$ (12% vs. 25%). Therefore, patients who are not candidates for docetaxel, who are intolerant of docetaxel, or who have pre-existing mild peripheral neuropathy should be considered for cabazitaxel.[608]

Cabazitaxel should be given with concurrent steroids (daily prednisone or dexamethasone on the day of chemotherapy). Physicians should follow current guidelines for prophylactic white blood cell growth factor use, particularly in this heavily pre-treated, high-risk population. In addition, supportive care should include antiemetics (prophylactic antihistamines, H2 antagonists, and corticosteroids prophylaxis) and symptom-directed antidiarrheal agents. Cabazitaxel was tested in patients with hepatic dysfunction in a small, phase I, dose-escalation study.[609] Cabazitaxel was tolerated in patients with mild to moderate hepatic impairment. However, cabazitaxel should not be used in patients with severe hepatic dysfunction. Cabazitaxel should be stopped upon clinical disease progression or intolerance.

### Sipuleucel-T

In April 2010, sipuleucel-T became the first in a new class of cancer immunotherapeutic agents to be approved by the FDA. This autologous cancer “vaccine” involves collection of the white blood cell fraction-containing, antigen-presenting cells from each patient; exposure of the cells to the prostatic acid phosphatase-granulocyte macrophage colony-stimulating factor (PAP-GM-CSF recombinant fusion protein); and subsequent reinfusion of the cells. The pivotal study was a phase 3, multicenter, randomized, double-blind trial (D9902B).[610] Five hundred twelve patients with minimally symptomatic or asymptomatic metastatic CRPC were randomized 2:1 to receive sipuleucel-T or placebo. Median survival in the vaccine arm was 25.8 months compared to 21.7 months in the control arm. Sipuleucel-T treatment resulted in a 22% reduction in mortality risk (HR, 0.78; 95% CI, 0.61–0.98; *P* = .03). Common complications included mild to moderate chills (54.1%), pyrexia (29.3%), and headache (16.0%), which usually were transient.

The panel prefers that sipuleucel-T be used as initial therapy for asymptomatic or minimally symptomatic patients with metastatic CRPC, so that disease burden is lower and immune function is potentially more intact. Clinicians and patients should be aware that the usual markers of benefit (decline in PSA and improvement in bone or CT scans) are not seen. Therefore, benefit to the individual patient cannot be ascertained using currently available testing.

### Pembrolizumab

The FDA approved the use of pembrolizumab, an anti-PD1 antibody, for treatment of patients with “unresectable or metastatic microsatellite instability-high (MSI-H) or mismatch repair (MMR)-deficient solid tumors who have progressed on prior treatment and who have no satisfactory alternative treatment options” on May 23, 2017.[611] The indication has since been expanded to include several cancer types, but not prostate cancer specifically.[612] The recommended adult dose of pembrolizumab for this indication is 200 mg intravenously once every 3 weeks.

FDA-accelerated approval was based on the treatment of 149 patients across 5 clinical studies involving MSI-H or MMR-deficient (dMMR) colorectal (n = 90) or non-colorectal (n = 59) cancer for an objective response rate of 40% (59/149).[611] All patients received ≥1 prior regimen. Among the non-colorectal cohorts, 2 patients had metastatic CRPC: one achieved a partial objective response, and the other achieved stable disease for >9 months.

A limited number of additional patients with metastatic CRPC treated with pembrolizumab have been reported.[63,613-615] In one study, only 1 patient had prostate cancer.[614] He had treatment-refractory, progressive, metastatic, dMMR disease and experienced a complete response; his prior therapy was not reported. In the other study, 10 patients with CRPC and non-visceral metastases (bone = 7; lymph nodes = 2; bone and liver = 1) who had disease progression on enzalutamide were treated with pembrolizumab and enzalutamide.[613] Some of the patients also had experienced disease progression on additional therapies (docetaxel for castration-naïve disease, abiraterone, and/or sipuleucel-T). Three of the 10 patients showed a near complete PSA response. Two of these 3 patients had radiographically measurable disease and achieved a partial radiographic response (including a response in liver metastases). Of the remaining patients, 3 showed stable disease, and 4 displayed no evidence of clinical benefit. Genetic analysis of biopsy tissue from 2 PSA responders and 2 PSA non-responders revealed that one responder had an MSI-H tumor, whereas the other responder and the non-responders did not. The nonrandomized phase Ib KEYNOTE-028 trial included 23 patients with advanced, progressive prostate cancer, of whom 74% had received ≥2 previous therapies for metastatic disease.[615] The objective response rate by investigator review was 17.4% (95% CI, 5.0%–38.8%), with 4 confirmed partial responses. Eight patients (34.8%) had stable disease. Treatment-related adverse events occurred in 61% of patients after a median follow-up of 7.9 months; 17% of the cohort experienced grade 3/4 events (ie, grade 4 lipase increase, grade 3 peripheral neuropathy, grade 3 asthenia, grade 3 fatigue).

The most common adverse events from pembrolizumab are fatigue, pruritus, diarrhea, anorexia, constipation, nausea, rash, fever, cough, dyspnea, and musculoskeletal pain. Pembrolizumab also may be associated with immune-mediated side effects, which include colitis, hepatitis, endocrinopathies, pneumonitis, or nephritis.

Based on the available data, the panel supports the use of pembrolizumab in patients with MSI-H or dMMR metastatic CRPC whose disease has progressed through at least one line of systemic therapy for M1 CRPC (category 2B). The prevalence of MMR deficiency in metastatic CPRC is estimated at 2% to 5%,[36,614] and testing for MSI-H or dMMR can be performed using DNA testing or immunohistochemistry. If tumor MSI-H or dMMR is identified, the panel recommends referral to genetic counseling for consideration of germline testing for Lynch syndrome.

### Treatment Implications for Patients with DNA Repair Gene Mutations

Early studies suggest germline and somatic mutations in homologous recombination repair genes (eg, *BRCA1*, *BRCA2*, *ATM*, *PALB2*, *FANCA*, *RAD51D*, *CHEK2*) may be predictive of the clinical benefit of poly-ADP ribose polymerase (PARP) inhibitors.[616-618] In particular, phase 2 data suggest that one PARP inhibitor, olaparib, has clinical activity in such patients, and trials of this agent and other PARP inhibitors are ongoing to assess the overall net clinical benefit of such therapy in men with CRPC, particularly in those men with either germline or somatically acquired DNA repair enzyme mutations.[617,618] One of these trials was randomized, double-blind, and placebo-controlled, and the primary endpoint of median radiographic progression-free survival was met (13.8 months in the olaparib/abiraterone arm vs. 8.2 months in the placebo/abiraterone arm; HR, 0.65; 95% CI, 0.44–0.97; *P* = .034).[618] The 142 patients in this trial were not selected based on mutational status. At present, no PARP inhibitor is approved for use in prostate cancer.

DNA repair defects have been reported to be predictive for sensitivity to platinum agents in CRPC and other cancers.[619-621] Platinum agents have shown some activity in patients with CRPC without molecular selection.[622] Studies of platinum agents in patients with CRPC that have DNA repair gene mutations are needed.

In addition, a recent study suggested that patients with metastatic CRPC and germline mutations in DNA repair genes may have better outcomes if treated with abiraterone or enzalutamide than with taxanes.[39] However, it should be noted that the response of patients with metastatic CRPC and homologous recombination repair gene mutations to standard therapies is similar to the response of patients without mutations.[623,624]

The panel recommends clinical trial enrollment for men with prostate cancer and DNA repair gene mutations.

### Agents Related to Bone Health in CRPC

In a multicenter study, 643 men with CRPC and asymptomatic or minimally symptomatic bone metastases were randomized to intravenous zoledronic acid every 3 weeks or placebo.[625] At 15 months, fewer men in the zoledronic acid 4-mg group than men in the placebo group had SREs (33% vs. 44%; *P* = .02). An update at 24 months also revealed an increase in the median time to first SRE (488 days vs. 321 days; *P* = .01).[626] No significant differences were found in OS. Other bisphosphonates have not been shown to be effective for prevention of disease-related skeletal complications. Earlier use of zoledronic acid in men with castration-sensitive prostate cancer and bone metastases is not associated with lower risk for SREs, and in general should not be used for SRE prevention until the development of metastatic CRPC.[627]

The randomized TRAPEZE trial used a 2 X 2 factorial design to compare clinical progression-free survival (pain progression, SREs, or death) as the primary outcome in 757 men with bone metastatic CRPC treated with docetaxel alone or with zoledronic acid, 89Sr, or both.[628] The bone-directed therapies had no statistically significant effect on the primary outcome or on OS in unadjusted analysis. However, adjusted analysis revealed a small effect for 89Sr on clinical progression-free survival (HR, 0.85; 95% CI, 0.73-0.99; *P* = .03). For secondary outcomes, zoledronic acid improved the SRE-free interval (HR, 0.78; 95% CI, 0.65–0.95; *P* = .01) and decreased the total SREs (424 vs. 605) compared with docetaxel alone.

Denosumab was compared to zoledronic acid in a randomized, double-blind, placebo-controlled study in men with CRPC.[629] The absolute incidence of SREs was similar in the 2 groups; however, the median time to first SRE was delayed by 3.6 months by denosumab compared to zoledronic acid (20.7 vs. 17.1 months; *P* = .0002 for non-inferiority, *P* = .008 for superiority). The rates of important SREs with denosumab were similar to zoledronic acid and included spinal cord compression (3% vs. 4%), need for radiation (19% vs. 21%), and pathologic fracture (14% vs. 15%).

Treatment-related toxicities reported for zoledronic acid and denosumab were similar and included hypocalcemia (more common with denosumab 13% vs. 6%), arthralgias, and osteonecrosis of the jaw (ONJ, 1%–2% incidence). Most, but not all, patients who develop ONJ have preexisting dental problems.[630]

## NCCN Recommendations

### Initial Prostate Cancer Diagnosis

Initial suspicion of prostate cancer is based on an abnormal DRE or an elevated PSA level. A separate NCCN Guidelines Panel has written guidelines for prostate cancer early detection (see the NCCN Guidelines for Prostate Early Detection, available at www.NCCN.org). Definitive diagnosis requires biopsies of the prostate, usually performed by a urologist using a needle under TRUS guidance. A pathologist assigns a Gleason primary and secondary grade to the biopsy specimen. Clinical staging is based on the TNM classification from the AJCC Staging Manual, 8th edition.[631] NCCN treatment recommendations are based on risk stratification that includes TNM staging rather than on AJCC prognostic grouping.

Pathology synoptic reports (protocols) are useful for reporting results from examinations of surgical specimens; these reports assist pathologists in providing clinically useful and relevant information. The NCCN Guidelines Panel favors pathology synoptic reports from the College of American Pathologists (CAP) that comply with the Commission on Cancer requirements.[632]

### Initial Clinical Assessment and Staging Evaluation

For patients with very-low-, low-, and intermediate-risk prostate cancer and a life expectancy of 5 years or less and without clinical symptoms, further workup and treatment should be delayed until symptoms develop. Those with a life expectancy ≤5 years who fall into the high- or very-high-risk categories should undergo bone imaging and, if indicated by nomogram prediction of lymph node involvement, pelvic +/- abdominal imaging. If regional or metastatic disease is found, then patients can be started on ADT. If the patient remains as N0M0, ADT or EBRT may be considered for selected patients with high- or very-high-risk disease, where complications, such as hydronephrosis or metastases, are likely within 5 years. Patients with life expectancies ≤5 years with high-risk, very-high-risk, regional, and metastatic disease are also candidates for observation if the risks and complications of therapy are judged to be greater than the benefit in terms of prolonged life or improved QOL.

For symptomatic patients and/or those with a life expectancy of greater than 5 years, bone imaging is appropriate for patients with unfavorable intermediate-risk prostate cancer and T2 disease with PSA over 10 ng/mL[633]; high- or very-high-risk disease;[148] or symptomatic disease. Pelvic +/- abdominal imaging is recommended for intermediate or higher risk disease when a nomogram indicates a >10% chance of lymph node involvement, although staging studies may not be cost-effective until the chance of lymph node positivity reaches 45%.[634] Alternative approaches to imaging based on the likelihood of a positive study rather than by risk group alone have been proposed based on data from a quality improvement collaborative in the state of Michigan.[146] For pelvic CT, the following criteria would identify almost all men with a positive study and reduce the number of negative studies: 1) PSA level >20 ng/mL; 2) Grade Group 4–5; or 3) clinical stage ≥T3. Use of these criteria may reduce the number of negative study results without missing a significant number of positive studies. Biopsy should be considered for further evaluation of suspicious nodal findings. For all other patients, no additional imaging is required for staging. NCCN panelists voiced concern about inappropriate use of PET imaging. F-18 PET/CT or PET/MRI is not recommended for initial assessment. However, F-18 sodium fluoride PET/CT or PET/MRI may be used after bone scan for further evaluation of equivocal findings.

Risk stratification and treatment options are described below. ADT as a primary treatment for localized prostate cancer does not improve survival and is not recommended by the NCCN Guidelines Panel. Cryotherapy or other local therapies are not recommended as routine primary therapy for localized prostate cancer due to lack of long-term data comparing these treatments to radiation or radical prostatectomy.

### Very Low Risk

Men with all of the following tumor characteristics are categorized in the very-low-risk group: clinical stage T1c, biopsy Grade Group 1, PSA <10 ng/mL, presence of disease in fewer than 3 biopsy cores, ≤50% prostate cancer involvement in any core, and PSA density <0.15 ng/mL/g. The use of targeted biopsy increases the chance that patients will have a higher number of positive cores or >50% involvement in some cores. Men with targeted biopsies who otherwise qualify for very-low-risk prostate cancer should still be considered as very low risk regardless of percent core involvement or number of positive cores in the targeted biopsies. A targeted lesion counts as one core.

Given the potential side effects of definitive therapy, men in this group who have an estimated life expectancy of less than 10 years should undergo observation (monitoring no more often than every 6 months). Unlike active surveillance, observation schedules do not involve biopsies. Men with very low risk and a life expectancy of 10 to 20 years should undergo active surveillance. For patients who meet the very-low-risk criteria but who have a life expectancy of 20 years or above, the NCCN Panel agreed that active surveillance (preferred), EBRT or brachytherapy, or radical prostatectomy are all viable options and should be discussed thoroughly.

### Low Risk

The NCCN Guidelines define the low-risk group as patients with clinical stage T1 to T2a, Grade Group 1, and serum PSA level <10 ng/mL. Observation is recommended for men with low-risk prostate cancer and a life expectancy of less than 10 years. If the patient's life expectancy is 10 years or more, initial treatment options include: 1) active surveillance (preferred); 2) EBRT or brachytherapy; or 3) radical prostatectomy. Molecular tumor testing can be considered for these men for prognostic information independent of NCCN risk groups (see *Tumor Multigene Molecular Testing*, above).

### Favorable Intermediate Risk

The NCCN Guidelines define the intermediate-risk group as patients with no high- or very-high-risk features and ≥1 IRF (T2b-T2c, Grade Group 2 or 3, PSA 10–20 ng/mL). Patients with intermediate risk fall into the favorable intermediate-risk group if they have no more than 1 IRF, Grade Group ≤2, and <50% of biopsy cores positive. Patients with multiple IRFs, Grade Group 3, or ≥50% positive cores should be shifted to the unfavorable intermediate-risk group.[96] The panel notes that an ultrasound-, MRI-, or DRE-targeted lesion that is biopsied more than once and demonstrates cancer counts as a single positive core for purposes of risk stratification.

Observation is indicated for patients in this risk group with a life expectancy ≤5 years. Options for patients with favorable intermediate-risk prostate cancer and a life expectancy of 5 to 10 years include: 1) observation (preferred); 2) EBRT; and 3) brachytherapy.

Men in this group with a life expectancy ≥10 years can consider molecular tumor testing for additional prognostic information independent of their NCCN risk group (see *Tumor Multigene Molecular Testing*, above). Initial treatment options for these patients include: 1) radical prostatectomy, with PLND if the predicted probability of lymph node metastasis is ≥2%; 2) EBRT; 3) brachytherapy; and 4) active surveillance. A multicenter cohort of 2550 men showed that the addition of ADT to the treatment options is unlikely to benefit men in the favorable intermediate-risk group.[635]

The literature on outcomes of active surveillance in men with intermediate-risk prostate cancer is limited.[636] In the PIVOT trial, men with clinically localized prostate cancer and a life expectancy ≥10 years were randomized to radical prostatectomy or observation.[637] Of the 120 participants with intermediate-risk disease who were randomized to observation, 13 died from prostate cancer, a non-significant difference compared with 6 prostate cancer deaths in 129 participants with intermediate-risk disease in the radical prostatectomy arm (HR, 0.50; 95% CI, 0.21–1.21; *P* = .12). After longer follow-up (median 12.7 years), a small difference was seen in all-cause mortality in those with intermediate-risk disease (absolute difference, 14.5 percentage points; 95% CI, 2.8–25.6), but not in those with low-risk disease (absolute difference, 0.7 percentage points; 95% CI, -10.5–11.8).[638] Urinary incontinence and erectile and sexual dysfunction, however, were worse through 10 years in the radical prostatectomy group. These results and the less-than-average health of men in the PIVOT study[639] suggest that men with competing risks may safely be offered active surveillance. Other prospective studies of active surveillance that included men with intermediate-risk prostate cancer resulted in prostate cancer-specific survival rates of 94% to 100% for the full cohorts.[197,198,200]

The panel interpreted these data to show that a subset of men with intermediate-risk prostate cancer may be considered for active surveillance, although longer-term follow-up is needed in these and others studies to increase confidence about the risks and benefits of active surveillance in this population. Men must understand that a significant proportion of men clinically staged as having favorable intermediate-risk prostate cancer may have higher risk disease.[640-643]

The panel believes that active surveillance may be considered for men with favorable intermediate-risk prostate cancer, but should be approached with caution, include informed decision-making, and use close monitoring for progression.

### Unfavorable Intermediate Risk

NCCN defines unfavorable intermediate risk as T2b-T2c, Grade Group 2-3, and/or PSA 10 to 20 ng/mL. Patients with only one of these risk factors, Grade Group 1 or 2, and fewer than 50% of biopsy cores positive for cancer fall into the favorable intermediate risk group.

Observation is indicated for patients in this risk group with a life expectancy ≤5 years and is the preferred option for men with a life expectancy of 5 to 10 years. Options for treatment for men with unfavorable intermediate risk include: 1) EBRT with or without 4 months of ADT; and 2) EBRT + brachytherapy with or without 4 months of ADT for life expectancy >5 years. Additionally, for men with a life expectancy ≥10 years, radical prostatectomy, with PLND if the predicted probability of lymph node metastasis is ≥2%, is an option for treatment.

Active surveillance is not recommended for patients with unfavorable intermediate-risk prostate cancer (category 1).

### High and Very High Risk

Men with prostate cancer that is clinical stage T3a, Grade Group 4–5, or PSA level greater than 20 ng/mL are categorized by the panel as high risk. Patients at very high risk (locally advanced) are defined by the NCCN Guidelines as men with clinical stage T3b to T4, primary Gleason pattern 5, or more than 4 biopsy cores with Grade Group 4–5.[644] Men in these risk groups can be considered for germline testing for mutations in homologous recombination genes (see *Homologous DNA Repair Genes*, above). Treatment options are the same for these 2 risk groups.

Selected asymptomatic patients with a life expectancy ≤5 years in these risk groups can be considered for ADT or EBRT if complications, such as hydronephrosis or metastasis, can be expected within 5 years. Otherwise, observation is indicated for most patients.

If life expectancy is >5 years or the patient is symptomatic, treatment options include EBRT in conjunction with 1.5 to 3 years of neoadjuvant/concurrent/adjuvant ADT (category 1 for the ADT component); ADT alone is insufficient. In particular, patients with low-volume, high-grade tumor warrant aggressive local radiation combined with 1.5 to 3 years of neoadjuvant/concurrent/adjuvant ADT. The shorter duration of ADT is supported by data from two randomized, phase 3 trials.[478,479] The combination of EBRT and brachytherapy, with 1 to 3 years of neoadjuvant/concurrent/adjuvant ADT, is another primary treatment option (category 1 for the ADT component).[399] Finally, radical prostatectomy with PLND remains an option. In particular, younger and healthier men may benefit from operation. Aggressive treatment is warranted in men with high- and very-high-risk prostate cancer, because 5-year prostate cancer-specific survival rates have been reported in the range of 75% to 98%.[645,646]

### Nodal Disease

The average time from lymph node metastasis to bone metastasis is 3 years, and survival is approximately 3 more years with ADT and perhaps 5 more years with ADT and new agents. EBRT to the primary tumor plus neoadjuvant/concurrent/adjuvant ADT (preferred) or ADT for castration-naïve disease are options for patients diagnosed with N1 disease on presentation and life expectancy >5 years. In addition, abiraterone may be added to either treatment (category 2B for abiraterone with methylprednisolone). Analysis of data from the control arm of STAMPEDE supports the use of EBRT with ADT in men with node-positive, non-metastatic disease.[647] Two-year FFS was improved with the planned use of radiation in this subset of trial participants (53% vs. 81%; HR, 0.48; 95% CI, 0.29–0.79). Data for the use of abiraterone for regional disease comes from the STAMPEDE trial, discussed in *Abiraterone Acetate in Castration-Naïve Prostate Cancer*, above.[502]

Observation and ADT are the recommended options for asymptomatic patients presenting with regional disease and life expectancy ≤5 years.

Positive nodal disease identified during radical prostatectomy is addressed under *Adjuvant or Salvage Therapy After Radical Prostatectomy*.

### Metastatic Disease

ADT is recommended for patients diagnosed with metastatic disease. Options are described in *ADT for Castration-Naïve Disease*, above. Abiraterone, docetaxel, or EBRT to the primary tumor is sometimes added to ADT as discussed in *Abiraterone Acetate in Castration-Naïve Prostate Cancer*; *Docetaxel*; and *EBRT to the Primary Tumor in Low-Volume M1 Disease*, above, respectively. Observation also is appropriate for asymptomatic patients with metastatic disease and life expectancy ≤5 years.

### Disease Monitoring

Patients treated with either medical or surgical ADT have increased risk for osteoporosis. A baseline bone mineral density study should be considered for these patients. Supplementation is recommended using calcium (500 mg) and vitamin D (400 IU). Men who are osteopenic/osteoporotic should be considered for denosumab, zoledronic acid, or alendronate.

#### *Patients on Active Surveillance*

For patients who choose active surveillance, an appropriate active surveillance schedule includes PSA measurement no more often than every 6 months unless clinically indicated, DRE no more often than every 12 months unless clinically indicated, and repeat prostate biopsy no more often than every 12 months unless clinically indicated. A repeat prostate biopsy within 6 months of diagnosis is indicated if the initial biopsy was less than 10 cores or if assessment results show discordance. Many clinicians choose to wait 2 years for a biopsy if there are no signs of progression. Repeat biopsies are not indicated when life expectancy is >10 years or when men are on observation.

Reliable parameters of prostate cancer progression await the results of ongoing clinical trials. Change in prostate exam or increase in PSA level may prompt consideration for repeat biopsy at the discretion of the physician. mpMRI may be considered to exclude the presence of anterior cancer if the PSA level increases and systematic prostate biopsy remains negative.[648] PSADT is not considered reliable enough to be used alone to detect disease progression.[649]

If repeat biopsy shows Grade Group ≥3 disease, or if tumor is found in a greater number of biopsy cores or in a higher percentage of a given biopsy core, cancer progression may have occurred.

#### *Patients After Initial Definitive Therapy*

For patients initially treated with intent to cure, serum PSA levels should be measured every 6 to 12 months for the first 5 years and then annually. PSA testing every 3 months may be better for men at high risk of recurrence. When prostate cancer recurred after radical prostatectomy, Pound and colleagues found that 45% of patients experienced recurrence within the first 2 years, 77% within the first 5 years, and 96% by 10 years.[650] Local recurrence may result in substantial morbidity and can, in rare cases, occur in the absence of a PSA elevation. Therefore, annual DRE is appropriate to monitor for prostate cancer recurrence and to detect colorectal cancer. Similarly, after EBRT, the monitoring of serum PSA levels is recommended every 6 months for the first 5 years and then annually and a DRE is recommended annually. The clinician may opt to omit the DRE if PSA levels remain undetectable.

#### *Patients with Castration-Naïve Disease on ADT*

The intensity of clinical monitoring for patients on ADT for castration-naïve disease is determined by the response to initial ADT, EBRT, or both. Follow-up evaluation of these patients should include history and physical examination and PSA measurement every 3 to 6 months based on clinical judgment. Bone imaging should be performed for symptoms and as often as every 6 to 12 months. The relative risk for bone metastasis or death increases as PSADT falls; a major inflection point appears at PSADT of 8 months. Bone imaging should be performed more frequently in these men.[651]

#### *Patients with Localized Disease Under Observation*

Patients with localized disease on observation follow the same monitoring recommendations as patients with castration-naïve disease who are on ADT, except that the physical exam and PSA measurement should only be done every 6 months.

#### *Workup for Progression*

Patients with advanced disease who show signs of progression should undergo disease workup with bone imaging, chest CT, and an abdominal/pelvic CT or abdominal/pelvic MRI with and without contrast. C-11 choline PET/CT or PET/MRI or F-18 fluciclovine PET/CT or PET/MRI can be considered for further soft tissue and bone evaluation, and F-18 sodium fluoride PET/CT or PET/MRI can be considered for further bone evaluation for patients without known metastatic disease (see *Nuclear Imaging*, above). The panel remains unsure what to do when M1 is suggested by PET-based imaging but not on conventional imaging.

### Adjuvant or Salvage Therapy After Radical Prostatectomy

Most patients who have undergone radical prostatectomy are cured of prostate cancer. However, some men will have adverse pathologic features, positive lymph nodes, or biochemical persistence or recurrence. Selecting men appropriately for adjuvant or salvage radiation is difficult. A multi-institutional, propensity score-matched cohort study compared post-radiation biochemical failure, freedom from distant metastases, and OS in 1,566 men with adverse pathologic features after radical prostatectomy who had received either adjuvant radiation or early salvage radiation for biochemical recurrence.[652] All 3 outcomes were improved with the use of adjuvant radiation. Prospective validation of these findings is needed, and at this time adjuvant radiation or observation may be considered in men with adverse pathologic features after radical prostatectomy.

***Adjuvant Therapy***

Adjuvant radiation with or without 6 months of ADT can be given to men with PSA persistence (failure of PSA to fall to undetectable levels) or adverse pathologic features (ie, positive margins, seminal vesicle invasion, extracapsular extension) who do not have lymph node metastases. Although observation after radical prostatectomy is appropriate, adjuvant EBRT after recuperation from operation is likely beneficial in men with one or more adverse laboratory or pathologic features, which include positive surgical margin, seminal vesicle invasion, and/or extracapsular extension as recommended in the guideline by the American Urological Association (AUA) and ASTRO.[653] Positive surgical margins are unfavorable, especially if diffuse (>10-mm margin involvement or ≥3 sites of positivity) or associated with persistent serum levels of PSA. The defined target volumes include the prostate bed.[654]

Published trials provide high-level evidence that can be used to counsel patients more appropriately regarding the use of adjuvant therapy. Thompson and colleagues reported the results of SWOG 8794, which enrolled 425 men with extraprostatic cancer found at radical prostatectomy. Patients were randomized to receive either adjuvant EBRT or usual care, and follow-up has reached a median of 12.6 years.[655] The initial study report revealed that adjuvant EBRT reduced the risk of PSA relapse and disease recurrence.[656] An update reported improved 10-year biochemical FFS for patients with high-risk disease (seminal vesicle positive) receiving post-prostatectomy adjuvant radiation compared to observation (36% vs. 12%; *P* = .001).[657]

Another randomized trial conducted by EORTC compared post-prostatectomy observation and adjuvant EBRT in 1005 patients.[658] All patients had extraprostatic disease and/or positive surgical margins. The 5-year biochemical progression-free survival significantly improved with EBRT compared to observation for patients with positive surgical margins (78% vs. 49%), but benefit was not seen for patients with negative surgical margins.

A German study by Wiegel and colleagues reported results on 268 patients.[659] All participants had extraprostatic disease and undetectable PSA levels after radical prostatectomy. Postoperative EBRT improved 5-year biochemical progression-free survival compared to observation alone (72% vs. 54%; HR, 0.53; 95% CI, 0.37–0.79). Collectively, these trial results suggest that continued follow-up of these series of patients may show a survival advantage.

The value of whole pelvic irradiation is unclear due to a lack of benefit in progression-free survival in 2 trials (RTOG 9413 and GETUG 01)[660-663]; whole pelvic radiation may be appropriate for selected patients.

Adjuvant therapy can also be given to men with positive lymph nodes found during or after radical prostatectomy. Several management options should be considered. ADT is a category 1 option, as discussed above (see *Adjuvant ADT for Lymph Node Metastases after RP*).[482] Another option is observation. Retrospective data show that initial observation may be safe in some men with N1 disease at radical prostatectomy, because 28% of a cohort of 369 patients remained free from biochemical recurrence at 10 years.[664] A third option is the addition of pelvic EBRT to ADT (category 2B). This last recommendation is based on retrospective studies and a National Cancer Database analysis that demonstrated improved biochemical recurrence-free survival, cancer-specific survival, and all-cause survival with post-prostatectomy EBRT and ADT compared to adjuvant ADT alone in patients with lymph node metastases.[665-668]

***Biochemical Recurrence After Radical Prostatectomy***

Men who suffer biochemical recurrence after radical prostatectomy fall into 3 groups: 1) those whose PSA level fails to fall to undetectable levels after radical prostatectomy (persistent disease); 2) those who achieve an undetectable PSA after radical prostatectomy with a subsequent detectable PSA level that increases on 2 or more subsequent laboratory determinations (PSA recurrence); or 3) the occasional case with persistent but low PSA levels attributed to slow PSA metabolism or residual benign tissue. Consensus has not defined a threshold level of PSA below which PSA is truly "undetectable."[152] Group 3 does not require further evaluation until PSA increases, but the workup for 1 and 2 must include an evaluation for distant metastases.

Several retrospective studies have assessed the prognostic value of various combinations of pretreatment PSA levels, Gleason scores, PSADT, and the presence or absence of positive surgical margins.[669-673] A large retrospective review of 501 patients who received salvage radiation for detectable and increasing PSA after radical prostatectomy[672] showed that the predictors of progression were Gleason score 8 to 10, pre-EBRT PSA level >2 ng/mL, seminal vesicle invasion, negative surgical margins, and PSADT ≤10 months. However, prediction of systemic disease versus local recurrence and hence responsiveness to postoperative radiation has proven unfeasible for individual patients using clinical and pathologic criteria.[674] Delivery of adjuvant or salvage EBRT becomes both therapeutic and diagnostic—PSA response indicates local persistence/recurrence. Delayed biochemical recurrence requires restaging, and a nomogram[104,675] may prove useful to predict response, but it has not been validated.

The specific staging tests depend on the clinical history, but should include a calculation of PSADT to inform nomogram use and counseling. In addition, bone imaging; chest CT; abdominal/pelvic CT or abdominal/pelvic MRI; C-11 choline PET/CT or PET/MRI or F-18 fluciclovine PET/CT or PET/MRI; and prostate bed biopsy may be useful. The Decipher molecular assay can be considered for prognostication after radical prostatectomy (category 2B). A meta-analysis of 5 studies with 855 patients and median follow-up of 8 years found that the 10-year cumulative incidence metastases rates for men classified as low, intermediate, and high risk by Decipher after radical prostatectomy were 5.5%, 15.0%, and 26.7%, respectively ($P < .001$).[676]

Bone imaging is appropriate when patients develop symptoms or when PSA levels are increasing rapidly. In one study, the probability of a positive bone scan for a patient not on ADT after radical prostatectomy was less than 5% unless the PSA increased to 40 to 45 ng/mL.[677] A TRUS biopsy may be helpful when imaging suggests local recurrence.

Patients with PSA recurrence (undetectable PSA that increases on two or more measurements) after radical prostatectomy may be observed or undergo primary salvage EBRT with or without ADT if distant metastases are not detected.[653]

Large retrospective cohort studies support the use of EBRT in the setting of biochemical recurrence, because it is associated with decreased all-cause and prostate cancer-specific survival.[674,678] The recommended post-radical prostatectomy EBRT dose is 64 to 72 Gy and may be increased for gross recurrence that has been proven by biopsy. The target volume includes the prostate bed and may include the whole pelvis in selected patients.[654] Treatment is most effective when pre-treatment PSA level is below 0.5 ng/mL.[675] Paradoxically, salvage EBRT was shown to be most beneficial when the PSADT time was <6 months in a cohort analysis of 635 men,[674] although another study of 519 men reported mortality reduction for both men with PSADT <6 months and those with PSADT ≥6 months.[678] Most men with prolonged PSADT may be observed safely.[679]

Six months of concurrent/adjuvant ADT can be coadministered with salvage radiation based on the results of GETUG-16.[680] An LHRH agonist should be used. Two years instead of 6 months of ADT can be considered in addition to radiation for men with persistent PSA after radical prostatectomy or for PSA levels that exceed 1.0 ng/mL at the time of initiation of salvage therapy, based on results of RTOG 9601.[465] For 2 years of ADT, level 1 evidence supports 150 mg bicalutamide daily but an LHRH agonist could be considered as an alternative.[465]

ADT alone becomes the salvage treatment when there is proven or high suspicion for distant metastases. Pelvic radiation is not recommended but may be given to the site of metastasis if in weight-bearing bones or if the patient is symptomatic. Observation remains acceptable for selected patients, with ADT delayed until symptoms develop or PSA levels suggest that symptoms are imminent. In all cases, the form of primary or secondary systemic therapy should be based on the hormonal status of the patient.

### Post-Irradiation Recurrence

The 2006 Phoenix definition was revised by ASTRO and the RTOG in Phoenix: 1) PSA rise by 2 ng/mL or more above the nadir PSA is the standard definition for biochemical recurrence after EBRT with or without hormonal therapy; and 2) A recurrence evaluation should be considered when PSA has been confirmed to be increasing after radiation even if the rise above nadir is not yet 2 ng/mL, especially in candidates for salvage local therapy who are young and healthy.[681] Retaining a strict version of the ASTRO definition allows comparison with a large existing body of literature. Rapid increase of PSA may warrant evaluation (prostate biopsy) prior to meeting the Phoenix definition, especially in younger or healthier men.

Further workup is indicated in patients who are considered candidates for local therapy. These patients include those with original clinical stage T1-2, life expectancy >10 years, and current PSA <10 ng/mL.[682] Workup typically includes PSADT calculation, bone imaging, TRUS biopsy, and prostate MRI; in addition, a chest CT, an abdominal/pelvic CT or abdominal/pelvic MRI, C-11 choline PET/CT or PET/MRI, or F-18 fluciclovine PET/CT or PET/MRI can be considered.

Local radiation recurrences are most responsive to salvage therapy when PSA levels at the time of treatment are low (<5 ng/mL). Biopsy should be encouraged at the time of radiation biochemical recurrence if staging workup does not reveal metastatic disease. Prostate biopsy in the setting of suspected local recurrence after radiation should be considered, including biopsy at the junction of the seminal vesicle and prostate, because this is a common site of recurrence.

Options for primary salvage therapy for those with positive biopsy but low suspicion of metastases to distant organs include observation or radical prostatectomy with PLND in selected cases by highly experienced surgeons. Salvage radical prostatectomy can result in long-term disease control, but is often associated with impotence and urinary incontinence.[683] Other options for localized interventions include cryotherapy,[684] HIFU,[446-449,453,454] and brachytherapy (reviewed by Allen and colleagues[685] and discussed in *Salvage Brachytherapy*). Treatment, however, needs to be individualized based on the patient's risk of progression, the likelihood of success, and the risks involved with salvage therapy.

Negative TRUS biopsy after post-radiation biochemical recurrence poses clinical uncertainties. Observation, ADT, and enrolling in clinical trials are viable options.

Patients with radiographic evidence of distant metastases should proceed to ADT for castration-naïve disease. Patients who were not initially candidates for local therapy should be treated with ADT or observed.

### Castration-Naïve Disease

The term "castration-naïve" is used to define patients who are not on ADT at the time of progression. The NCCN Prostate Cancer Panel uses the term "castration-naïve" even when patients have had neoadjuvant, concurrent, or adjuvant ADT as part of RT provided they have recovered testicular function. Options for patients with castration-naïve disease who require ADT depend on the presence of distant metastases. Men with M0 disease can undergo orchiectomy or ADT with LHRH agonist with or without an antiandrogen or LHRH antagonist or they can be observed until symptoms develop or are imminent. Options for men with M1 disease and life expectancy >5 years include: 1) ADT and docetaxel (category 1); 2) ADT and abiraterone with prednisone (category 1); 3) ADT and EBRT to the primary tumor for low-volume M1; 4) ADT alone; and 5) ADT and abiraterone with methylprednisolone (category 2B). ADT alone or observation are recommended for asymptomatic patients with M1 disease and life expectancy ≤5 years.

The option of upfront docetaxel and ADT is based on results from the phase 3 CHAARTED and STAMPEDE trials (as discussed under *Docetaxel)*.[599,600] Abiraterone use in the metastatic castration-naïve setting is based on results of STAMPEDE (see *Abiraterone Acetate in Castration-Naïve Prostate Cancer*, above).[502] The direct randomized comparison of docetaxel with ADT and abiraterone with ADT in STAMPEDE showed that the two treatment options resulted in similar efficacy and safety outcomes.[686]

Docetaxel should not be offered to men with M0 castration-naïve prostate cancer based on results of a pre-planned subgroup analysis of the STAMPEDE trial that showed no OS benefit for participants with M0 disease.[599] Men with low-volume metastatic disease can be offered early treatment with docetaxel combined with ADT; however, they have less certain benefit from treatment than men with higher-volume disease, as this subgroup did not have definitively improved survival outcomes in the ECOG CHAARTED study or a similar European trial (GETUG-AFU 15).[600,687,688] Meta-analyses of randomized controlled trials also concluded that docetaxel provides a significant OS benefit in this setting, with no evidence that the benefit was dependent on the volume of disease.[689-691]

In the setting of non-metastatic, biochemical relapse after local therapy, observation is preferred over ADT based on results of the TOAD trial (see *ADT for M0 Biochemical Recurrence*, above).[494] Men who opt for ADT should consider the intermittent approach. The timing of ADT initiation should be individualized according to PSA velocity, patient anxiety, and potential side effects. Patients with shorter PSADT or rapid PSA velocity and long life expectancy may be encouraged to consider early ADT. Men with prolonged PSADTs who are older are excellent candidates for observation.

Patients with metastatic disease should be queried about adverse effects related to ADT. Intermittent ADT should be used for those who experience significant side effects of ADT. Some men who have no ADT-related morbidity may find the uncertainty of intermittent ADT not worthwhile. Intermittent ADT requires close monitoring of PSA and testosterone levels, especially during off-treatment periods, and patients may need to switch to continuous therapy upon signs of disease progression.

Combined androgen blockade therapy adds to cost and side effects, and prospective randomized evidence that combined androgen blockade is more efficacious than ADT is lacking.

### Progression to CRPC

CRPC is prostate cancer that progresses clinically, radiographically, or biochemically despite castrate levels of serum testosterone (<50 ng/dL).[692] Patients whose disease progresses to CRPC during primary ADT should receive a laboratory assessment to assure a castrate level of testosterone (<50 ng/dL; <1.7 nmol/L). Imaging tests may be indicated to monitor for signs of distant metastases. Factors affecting the frequency of imaging include individual risk, age, overall patient health, PSA velocity, and Gleason grade.

A number of options for systemic therapy should be considered based on metastasis status, as discussed in the following sections.

### CRPC Without Signs of Metastasis

Patients with CRPC and no signs of distant metastasis on conventional imaging studies (M0) can consider observation if PSADT is >10 months, because these patients will have a relatively indolent disease history.[693] Secondary hormone therapy is an option mainly for patients with shorter PSADT (≤10 months), because the androgen receptor may remain active. Specifically, apalutamide or enzalutamide may be considered if PSADT is ≤10 months (see *Secondary Hormone Therapy for CRPC*, above).[592] Patients whose disease progresses on combined androgen blockade can have the antiandrogen discontinued to exclude an "antiandrogen withdrawal response."[694,695]

### Metastatic CRPC

All patients with metastatic CRPC should maintain castrate levels of serum testosterone (<50 ng/dL; <1.7 nmol/L) through continuation of LHRH agonist or antagonist and should receive best supportive care. Metastatic lesion biopsy can be considered. These patients also can be considered for MSI/MMR testing. If MSI-H or dMMR is found, referral to genetic counseling should be made to assess for the possibility of Lynch syndrome. These patients can be considered for germline and tumor testing to check for mutations in homologous recombination genes (ie, *BRCA1*, *BRCA2*, *ATM*, *PALB2*, *FANCA*).[696] This information may be used for genetic counseling, early use of platinum chemotherapy, or eligibility for clinical trials (eg, PARP inhibitors).

Treatment options for specific settings are discussed below.

#### *Small Cell/Neuroendocrine Prostate Cancer*

*De novo* small cell carcinoma in untreated prostate cancers occurs rarely and is very aggressive.[697] Treatment-associated small cell/neuroendocrine prostate cancer that occurs in men with metastatic CRPC is more common.[698] In a multi-institution prospective series of 202 consecutive patients with metastatic CRPC, all of whom underwent metastatic biopsies, small cell/neuroendocrine histology was present in 17%.[698] Patients with small cell/neuroendocrine tumors and prior abiraterone and/or enzalutamide had a shorter OS when compared with those with adenocarcinoma and prior abiraterone and/or enzalutamide (HR, 2.02; 95% CI, 1.07–3.82). Genomic analysis showed that DNA repair mutations and small cell/neuroendocrine histology were almost mutually exclusive.

Small cell/neuroendocrine carcinoma of the prostate should be considered in patients who no longer respond to ADT and test positive for metastases. These relatively rare tumors are associated with low PSA levels despite large metastatic burden and visceral disease.[699] Those with initial Grade Group 5 are especially at risk. Biopsy of accessible metastatic lesions should be considered to identify patients with small cell/neuroendocrine histomorphologic features in patients with visceral metastases.[700]

These cases may be managed by cytotoxic chemotherapy (ie, cisplatin/etoposide, carboplatin/etoposide, docetaxel/carboplatin).[701,702] Participation in a clinical trial is another option. Physicians should consult the NCCN Guidelines for Small Cell Lung Cancer (available at www.NCCN.org), because the behavior of small cell/neuroendocrine carcinoma of the prostate is similar to that of small cell carcinoma of the lung.

***Bone Metastases***

Denosumab every 4 weeks (category 1) or zoledronic acid every 3 to 4 weeks is recommended for men with CRPC and bone metastases to prevent or delay disease-associated SREs. SREs include pathologic fractures, spinal cord compression, operation, or EBRT to bone. The optimal duration of zoledronic acid or denosumab in men with CRPC and bone metastases remains unclear. A multi-institutional, open-label, randomized trial in 1822 patients with bone-metastatic prostate cancer, breast cancer, or multiple myeloma found that zoledronic acid every 12 weeks was non-inferior to zoledronic acid every 4 weeks.[703] In the every-12-weeks and every-4-weeks arms, 28.6% and 29.5% experienced at least 1 SRE within 2 years of randomization, respectively.

Oral hygiene, baseline dental evaluation for high-risk individuals, and avoidance of invasive dental surgery during therapy are recommended to reduce the risk of ONJ.[704] If invasive dental surgery is necessary, therapy should be deferred until the dentist confirms that the patient has healed completely from the dental procedure. Supplemental calcium and vitamin D are recommended to prevent hypocalcemia in patients receiving either denosumab or zoledronic acid.

Monitoring of creatinine clearance is required to guide dosing of zoledronic acid. Zoledronic acid should be dose reduced in men with impaired renal function (estimated creatinine clearance 30–60 mL/min), and held for creatinine clearance <30 mL/min.[705] Denosumab may be administered to men with impaired renal function or even men on hemodialysis; however, the risk for severe hypocalcemia and hypophosphatemia is greater, and the dose, schedule, and safety of denosumab have not yet been defined. A single study of 55 patients with creatinine clearance <30 mL/min or on hemodialysis evaluated the use of 60-mg-dose denosumab.[706] Hypocalcemia should be corrected before starting denosumab, and serum calcium monitoring is required for denosumab and recommended for zoledronic acid, with repletion as needed.

Clinical research continues on the prevention or delay of disease spread to bone. A phase 3 randomized trial of 1432 patients with non-metastatic CRPC at high risk of bone involvement showed that denosumab delayed bone metastasis by 4 months compared to placebo.[707] OS was not improved, and the FDA did not approve this indication for denosumab.

Radium-223 is a category 1 option to treat symptomatic bone metastases without visceral metastases. Hematologic evaluation should be performed according to the FDA label before treatment initiation and before each subsequent dose.[708] Radium-223 given in combination with chemotherapy (such as docetaxel) outside of a clinical trial has the potential for additive myelosuppression.[708] Radium-223 can be used with denosumab or zoledronic acid.

The use of systemic radiation with either 89Sr or 153Sm occasionally benefits patients with widely metastatic, painful, skeletal involvement that is not responding to palliative chemotherapy or systemic analgesia and who are not candidates for localized EBRT.[430] The risk of bone marrow suppression, which might influence the ability to provide additional systemic chemotherapy, should be considered before this therapy is initiated.

***M1 CRPC without Visceral Metastases***

Based on phase 3 randomized trial evidence, sipuleucel-T is a category 1 recommended option for patients with metastatic CRPC who are asymptomatic or minimally symptomatic, and have good performance level (ECOG 0-1), estimated life expectancy >6 months, and no liver metastases (see *Sipuleucel-T*, above).[610] Sipuleucel-T has not been studied in patients with visceral metastases. The panel prefers that sipuleucel-T only be used as initial therapy for metastatic CRPC. Treatment subsequent to sipuleucel-T treatment should proceed as clinically indicated, particularly if symptoms develop. Enzalutamide and abiraterone with prednisone also are category 1 options for first-line therapy of patients with asymptomatic, chemotherapy-naïve, metastatic CRPC. Abiraterone with methylprednisolone is another option.

Docetaxel with concurrent steroid is the traditional mainstay of treatment for symptomatic metastases (category 1). Docetaxel is not commonly used for asymptomatic patients, but may be considered when the patient shows signs of rapid progression or visceral metastases despite lack of symptoms. Treatment with ≥8 cycles docetaxel may be associated with better OS than fewer cycles in the metastatic CRPC setting, but prospective trials are necessary to test 6 versus 10 cycles of docetaxel in the metastatic castration-naïve and CRPC settings.[709] Retrospective analysis from the GETUG-AFU 15 trial suggests that docetaxel only benefits some patients with CRPC who received docetaxel in the castration-naïve setting.[710]

Radium-223 is a category 1 option to treat symptomatic bone metastases without visceral metastases. Other options for patients with M1 CRPC without visceral metastases include clinical trial participation and other secondary hormone therapy (first-generation antiandrogen, antiandrogen withdrawal, ketoconazole with or without hydrocortisone, corticosteroid, DES, or other estrogens). Ketoconazole should not be used if the disease progressed on abiraterone; both drugs inhibit CYP17A1.

### *CRPC with Visceral Metastases*

The panel defines visceral metastases as those occurring in the liver, lung, adrenal gland, peritoneum, or brain. Soft tissue/lymph node sites are not considered visceral metastases. Every-3-week docetaxel and prednisone is the preferred first-line chemotherapy treatment for symptomatic CRPC with visceral metastases (category 1). PSA increase alone does not define progression on docetaxel; the patient may benefit from continued chemotherapy if clinical progression is not apparent. The addition of estramustine to docetaxel has been shown to increase side effects without enhancing efficiency and is not recommended.[711]

Enzalutamide is another category 1 recommended option in this setting. Abiraterone has not been assessed formally in symptomatic men with CRPC prior to docetaxel. Therefore, its use in these patients is a category 2A recommendation. Use of abiraterone is reasonable for men who are not candidates for docetaxel or who decline chemotherapy.

Mitoxantrone may provide palliative benefit for symptomatic patients who cannot tolerate docetaxel.[712,713] Clinical trials and other secondary hormone therapies are additional options.

Radium-223 alone has not been shown to extend survival in men with visceral metastases or bulky lymph node metastases (>3–4 cm) and is not recommended in this setting.

Additional treatment options can be continued beyond second-line therapy in patients with visceral metastases (category 2B), as delineated in the guidelines. Clinical trial and best supportive care are additional options.

### *Progression After Enzalutamide or Abiraterone*

Patients with disease progression after enzalutamide or abiraterone have the following options: docetaxel (category 1), abiraterone if previously given enzalutamide therapy, enzalutamide if previously given abiraterone, radium-223 for bone-predominant disease without visceral metastases (category 1), sipuleucel-T if asymptomatic or minimally symptomatic and without visceral metastases, life expectancy >6 months, and ECOG score 0–1, pembrolizumab if MSI-H/dMMR (category 2B), clinical trial, or secondary hormone therapy. All patients can continue through all treatment options and should receive best supportive care.

No randomized trials that compare taxane chemotherapies versus novel hormonal therapies in this setting have been reported, and some data suggest cross-resistance between abiraterone and enzalutamide.[714-717] One molecular biomarker that may aid appropriate selection of therapy after progression on abiraterone or enzalutamide is the presence of androgen receptor splice variant 7 (AR-V7) in CTCs.[718] Lack of response of men with metastatic CRPC to abiraterone and enzalutamide was associated with detection of AR-V7 mRNA in CTCs using an RNA-based polymerase chain reaction (PCR) assay.[719] AR-V7 presence did not preclude clinical benefit from taxane chemotherapies (docetaxel and cabazitaxel).[720] Men with AR-V7–positive CTCs exhibited superior progression-free survival with taxanes compared to novel hormonal therapies (abiraterone and enzalutamide); the two classes of agents resulted in comparable progression-free survival in men with AR-V7–negative CTCs. A confirmatory study used a different CTC assay that detected nuclear-localized AR-V7 protein using immunofluorescence. Men with AR-V7–positive CTCs had superior OS with taxanes versus abiraterone or enzalutamide, whereas OS was not different between the two classes of agents among patients with AR-V7–negative CTCs.[721] A blinded, correlative study at 3 cancer centers assessed the correlation between AR-V7 results before second-line treatment and OS in men with metastatic CRPC.[722] Approximately half of the validation cohort received taxane therapy in first line, whereas half received an androgen receptor signaling inhibitor. In a high-risk subset of this cohort, patients negative for AR-V7 had superior OS if they were treated with an androgen receptor signaling inhibitor than if they were treated with a taxane (median OS, 19.8 vs. 12.8 months; HR, 1.67; 95% CI, 1.00–2.81; $P = .05$). Thus AR-V7 may be a useful predictive biomarker in men with metastatic CRPC after progression on abiraterone or enzalutamide.

These clinical experiences suggest that AR-V7 assays are promising predictors of abiraterone and enzalutamide resistance. Furthermore, the prevalence of AR-V7 positivity is only 3% in patients prior to treatment with enzalutamide, abiraterone, and taxanes,[721] so the panel believes AR-V7 detection would not be useful to inform treatment decisions in the naïve setting. On the other hand, the prevalence of AR-V7 positivity is higher after progression on abiraterone or enzalutamide (19%–39%[719]), but data have already shown that abiraterone/enzalutamide crossover therapy is rarely effective and taxanes are more effective in this setting. The panel recommends that use of AR-V7 tests can be considered to help guide selection of therapy in the post-abiraterone/enzalutamide metastatic CRPC setting.

### *Progression After Docetaxel*

Both abiraterone with prednisone and enzalutamide represent standard of care after progression on docetaxel for metastatic CRPC (category 1), provided these agents were not used before docetaxel. Other options include radium-223 for symptomatic bone metastases without visceral metastases (category 1), cabazitaxel (category 1), sipuleucel-T if not previously given and if asymptomatic or minimally symptomatic and without visceral or liver metastases (life expectancy >6 months and ECOG score 0–1), abiraterone with methylprednisolone, pembrolizumab if MSI-H/dMMR (category 2B), clinical trial, docetaxel rechallenge, mitoxantrone with prednisone, and other secondary hormone therapy. Patients can continue through all treatment options and should receive best supportive care.

The decision to initiate therapy in the post-docetaxel CRPC setting should be based on the available high-level evidence of safety, efficacy, and tolerability of these agents and the application of this evidence to an individual patient. Prior exposures to these agents should be considered. No data inform the proper sequence for delivery of these agents in men with metastatic CRPC. No randomized trials have been reported that compared these agents, and no predictive models or biomarkers help to identify patients who are likely to benefit from any of these agents. Choice of therapy is based largely on clinical considerations, which include patient preferences, prior treatment, presence or absence of visceral disease, symptoms, and potential side effects. NCCN recommends that patients be closely monitored with radiologic imaging (ie, CT, bone imaging), PSA tests, and clinical exams for evidence of progression. Therapy should be continued until clinical progression or intolerability in cases where PSA or bone imaging changes may indicate flare rather than true clinical progression.[723,724] The sequential use of these agents is reasonable in a patient who remains a candidate for further systemic therapy.

The NCCN Guidelines Panel included cabazitaxel as an option for second-line therapy after progression on docetaxel for patients with symptomatic metastatic CRPC. This recommendation is category 1 based on randomized phase 3 study data (see *Cabazitaxel*, above).[604,608] NCCN panelists agreed that docetaxel rechallenge may be useful in some patients (category 2A instead of category 1 in this setting), especially in those who have not shown definitive evidence of progression on prior docetaxel therapy. Docetaxel rechallenge can be considered in patients who received docetaxel with ADT in the metastatic castration-naïve setting.

Some patients with metastatic CRPC may be deemed unsuitable for taxane chemotherapy; such patients could be considered for radium-223 or a second-line hormonal agent. In addition, mitoxantrone remains a palliative treatment option for men who are not candidates for taxane-based therapy based on older randomized studies that showed palliative benefit.[712,713] No chemotherapy regimen has demonstrated improved survival or QOL after cabazitaxel, although several systemic agents other than mitoxantrone have shown palliative and radiographic response benefits in clinical trials (ie, carboplatin, cyclophosphamide, doxorubicin, vinorelbine, carboplatin/etoposide, docetaxel/carboplatin, gemcitabine/oxaliplatin, paclitaxel/carboplatin[725-734]). Prednisone or dexamethasone at low doses may provide palliative benefits in the chemotherapy-refractory setting.[735] No survival benefit for combination regimens over sequential single-agent regimens has been demonstrated, and toxicity is higher with combination regimens. Treatment with these agents could be considered after an informed discussion between the physician and an individual patient about treatment goals and risks/side effects and alternatives, which must include best supportive care. Participation in a clinical trial is encouraged.

In the phase 3 sipuleucel-T trial, 18.2% of patients had received prior chemotherapy, which included docetaxel, because eligibility requirements included no chemotherapy for 3 months and no steroids for 1 month prior to enrollment.[610] These men were asymptomatic or minimally symptomatic. In a subset analysis, both those who did and those who did not receive prior chemotherapy benefited from sipuleucel-T treatment.

## Summary

The intention of these guidelines is to provide a framework on which to base treatment decisions. Prostate cancer is a complex disease, with many controversial aspects of management and with a dearth of sound data to support many treatment recommendations. Several variables (including adjusted life expectancy, disease characteristics, predicted outcomes, and patient preferences) must be considered by the patient and physician to tailor prostate cancer therapy for the individual patient.

## Table 1. Available Tissue-Based Tests for Prostate Cancer Risk Stratification/Prognosis

| Test | Platform | Populations Studied | Outcome(s) Reported (Test independently predicts) | Selected References | Molecular Diagnostic Services Program (MolDX) Recommendations |
|---|---|---|---|---|---|
| **Decipher** | Whole-transcriptome 1.4M RNA expression (44,000 genes) oligonucleotide microarray optimized for FFPE tissue | Post radical prostatectomy (RP), adverse pathology/high-risk features | • Metastasis<br>• Prostate cancer-specific mortality<br>• Postoperative radiation sensitivity (PORTOS) | 140,143,144,243 ,676,736-748 | Cover post-biopsy for NCCN very-low- and low-risk prostate cancer in patients with at least 10 years life expectancy who have not received treatment for prostate cancer and are candidates for active surveillance or definitive therapy<br>Cover post-RP for 1) pT2 with positive margins; 2) any pT3 disease; 3) rising PSA (above nadir) |
| | | Post RP, biochemical recurrence | • Metastasis<br>• Prostate cancer-specific mortality<br>• PORTOS | | |
| | | Post RP, adjuvant, or salvage radiation | • Metastasis<br>• Prostate cancer-specific mortality<br>• PORTOS | | |
| | | Biopsy, localized prostate cancer post RP or EBRT | • Metastasis<br>• Prostate cancer-specific mortality<br>• Gleason grade ≥4 disease at RP<br>• Adverse pathologic features at RP | | |
| **Ki-67** | IHC | Biopsy, intermediate- to high-risk treated with EBRT | • Metastasis | 749-752 | Not recommended |
| | | Biopsy, conservatively managed (active surveillance) | • Prostate cancer-specific mortality | | |
| **Onco*type* DX Prostate** | Quantitative RT-PCR for 12 prostate cancer-related genes and 5 housekeeping controls | Biopsy, low- to intermediate-risk treated with RP | • Non-organ-confined pT3 or Gleason grade 4 disease on RP | 139,753-756 | Cover post-biopsy for NCCN very-low-, low-risk, and favorable intermediate-risk prostate cancer in patients with at least 10 years life expectancy who have not received treatment for prostate cancer and are candidates for active surveillance or definitive therapy |
| **Prolaris** | Quantitative RT-PCR for 31 cell cycle-related genes and 15 housekeeping controls | Transurethral resection of the prostate (TURP), conservatively managed (active surveillance) | • Prostate cancer-specific mortality | 135-138,757-759 | Cover post-biopsy for NCCN very-low-, low-risk, and favorable intermediate-risk prostate cancer in patients with at least 10 years life expectancy who have not received treatment for prostate cancer and are candidates for active surveillance or definitive therapy |
| | | Biopsy, conservatively managed (active surveillance) | • Prostate cancer-specific mortality | | |
| | | Biopsy, localized prostate cancer | • Biochemical recurrence<br>• Metastasis | | |
| | | Biopsy, intermediate-risk treated with EBRT | • Biochemical recurrence | | |
| | | RP, node-negative localized prostate cancer | • Biochemical recurrence | | |
| **ProMark** | Multiplex immunofluorescent staining of 8 proteins | Biopsy, Gleason grade 3+3 or 3+4 | • Non–organ-confined pT3 or Gleason pattern 4 disease on RP | 760 | Cover post-biopsy for NCCN very-low- and low-risk prostate cancer in patients with at least 10 years life expectancy who have not received treatment for prostate cancer and are candidates for active surveillance or definitive therapy. |
| **PTEN** | Fluorescence in situ hybridization or IHC | TURP, conservatively managed (active surveillance) | • Prostate cancer-specific mortality | 761-765 | Not recommended |
| | | Biopsy, Gleason grade 3+3 | • Upgrading to Gleason pattern 4 on RP | | |
| | | RP, high-risk localized disease | • Biochemical recurrence | | |

## Table 2. Summary of Main PET Imaging Tracers Studied in Prostate Cancer*

| Tracer | Half-life (min) | Cyclotron | Mechanism of Action | Excretion | Sensitivity (%)* | Specificity (%)* | FDA Status | Panel Recommendation |
|---|---|---|---|---|---|---|---|---|
| C-11 choline | 20 | Onsite | Cell membrane synthesis | Hepatic | 32–93 | 40–93 | • Cleared | • May be used for detection of biochemically recurrent small-volume disease in soft tissues<br>• May be used after bone scan for further evaluation of equivocal findings |
| F-18 fluciclovine | 110 | Regional | Amino acid transport | Renal | 37–90 | 40–100 | • Cleared | • May be used for detection of biochemically recurrent small-volume disease in soft tissues<br>• May be used after bone scan for further evaluation of equivocal findings |
| F-18 NaF | 110 | Regional | Adsorption within bone matrix | Hepatic | 87–100 | 62–89 | • Cleared | • May be used after bone scan for further evaluation of equivocal findings |
| C-11 acetate | 20 | Onsite | Lipid synthesis | Lung | 59–69 | 83–98 | • Not cleared | • May be used in clinical trial or registry |
| Ga-68 PSMA | 68 | Generator (no cyclotron) | PSMA analog | Renal | 76–86 | 86–100 | • Not cleared | • May be used in clinical trial or registry |

* Interpret with caution; few studies used biopsy/surgery as gold standard; see *Nuclear Imaging*, above, for references.

## Table 3. Selected Active Surveillance Experiences in North America

| **Center** | **Toronto**[197,262,268] | **Johns Hopkins**[199,260,263,264] | **UCSF**[261] | **UCSF (newer cohort)**[766] | **Canary PASS**[271] |
|---|---|---|---|---|---|
| No. patients | 993 | 1298 | 321 | 810 | 905 |
| Median age (y) | 68 | 66 | 63 | 62 | 63 |
| Median follow-up (months) | 77 | 60 | 43 | 60 | 28 |
| Overall survival | 80% (10-y) | 93% (10-y) | 98% (10-y) | 98% (5-y) | - |
| Cancer-specific survival | 98% (10-y) | 99.9% (10-y) | 100% (5-y) | - | - |
| Conversion to treatment | 36.5% (10-y) | 50% (10-y) | 24% (3-y) | 40% (5-y) | 19% (28-mo) |
| **Reason for treatment (% of entire cohort)** | | | | | |
| Gleason grade change | 9.5% | 15.1% | 38% | - | - |
| PSA increase | 11.7%* | - | 26%† | - | - |
| Positive lymph node | - | 0.4% | - | - | - |
| Personal choice | -1.6% | 8% | 8% | - | - |

* PSA doubling time <3 years

† PSA velocity >0.75 ng/mL/year

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