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NCCN Clinical Practice Guidelines in Oncology (NCCN Guidelines®)

Prostate Cancer Early Detection

Version 1.2017 — June 5, 2017

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NCCN Guidelines Version 1.2017

Prostate Cancer Early Detection Panel Members

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To find clinical trials online at NCCN member institutions, [click here: nccn.org/clinical_trials/physician.html](#).

NCCN Categories of Evidence and Consensus: All recommendations are Category 2A unless otherwise specified.

See [NCCN Categories of Evidence and Consensus](#).

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NCCN Guidelines Version 1.2017 Updates

Prostate Cancer Early Detection

Updates in Version 1.2017 of the NCCN Guidelines for Prostate Cancer Early Detection from Version 2.2016 include:

PROSD-2

• Baseline Evaluation:

- ▶ Modified footnote “a”, replaced “However, the effects of earlier or more intensive screening on cancer outcomes and on screening-related harms in African-American men remain unclear. Therefore, although these men may require a higher level of vigilance and different considerations when analyzing the results of screening tests, the panel cannot provide separate screening recommendations for these men until more data become available.” with “*This is attributable to a greater risk of developing preclinical prostate cancer and a higher likelihood that a preclinical tumor will spread. Consequently it is reasonable for African-American men to begin discussing PSA screening with their providers several years earlier than Caucasian-American men and to consider screening at annual intervals rather than every other year.*”
- ▶ Modified “Family or personal history of BRCA 1/2 mutations.”
- ▶ Added a footnote to “Family history of BRCA 1/2 mutations.”
 - ◊ New footnote states: “If there is a known or suspected cancer susceptibility gene, referral to a cancer-genetics professional is recommended. BRCA1/2 pathogenic mutation carriers are associated with an increased risk of prostate cancer before age 65 years, and prostate cancer in men with germline BRCA2 mutations occurs earlier and is more likely to be associated with prostate cancer mortality. Information regarding BRCA1/2 gene status should be used as part of the discussion about prostate cancer screening. [See Discussion.](#)”

• Risk Assessment:

- ▶ Modified last bullet “Strongly consider baseline digital rectal examination (DRE).”

• Early Detection Evaluation:

- ▶ Age >75y, in select patients (category 2B), changed from “PSA >3 ng/mL or very suspicious DRE” to “PSA ≥4 ng/mL or very suspicious DRE.”
- ▶ Footnote “c”, added reference. Halpern JA, Shoag JE, Mittal S, et al. Prognostic significance of digital rectal examination and prostate specific antigen in the prostate, lung, colorectal and ovarian (PLCO) cancer screening arm. J Urol 2017;197:363-368.
- ▶ The following sentence was removed from footnote “d”: “One could consider increasing the PSA threshold for biopsy in this group (i.e., >4 ng/mL).”



NCCN Guidelines Version 1.2017

Prostate Cancer Early Detection

Updates in Version 1.2017 of the NCCN Guidelines for Prostate Cancer Early Detection from Version 2.2016 include:

[PROSD-3](#)

• Indications for Biopsy:

- ▶ DRE, added “if not performed during initial risk assessment.”
- ▶ Moved “Consider percent free PSA, 4Kscore, or PHI” to prior to TRUS-guided biopsy.
- ▶ Added “Consider multiparametric MRI.”

• Management:

- ▶ Added a new footnote to “Follow up in 6-12 mo with PSA/DRE.”
 - ◇ New footnote states “Patients with a persistent and significant increase in PSA should be encouraged to undergo TRUS-guided biopsy.”
- ▶ Modified footnote “h”, “Biomarkers that improve the specificity of detection are not, as yet, recommended as firstline screening tests. However, there may be some patients who meet PSA standards for consideration of prostate biopsy, but for whom the patient and/or the physician wish to further define the probability of high-grade cancer. A percent free PSA <10%, PHI >35 or 4Kscore (which provides an estimate of the probability of high-grade prostate cancer) are potentially informative in patients who have never undergone biopsy or after a negative biopsy; a PCA3 score >35 is potentially informative after a negative biopsy. The predictive value of the serum biomarkers discussed above has not been correlated with that of MRI. Therefore it is not known how such tests could be applied in optimal combination.”
- ▶ The following sentence was removed from footnote “j”, “MRI is not recommended routinely prior to initial prostate biopsy.”
- ▶ Added a new reference to footnote “j”, Ahmed H, Bosaily A, Brown L, et al. Diagnostic accuracy of multi-parametric MRI and TRUS biopsy in prostate cancer (PROMIS): a paired validating confirmatory study. Lancet 2017;389:815-822.

[PROSD-4](#)

• Management of Biopsy Results:

- ▶ Atypia, suspicious for cancer, revised recommendation to state:
 - ◇ Follow-up:
 - Consider serum or urine tests and/or multiparametric MRI
 - Consider repeated biopsy with relative increased sampling of the atypical site

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.



NCCN Guidelines Version 1.2017 Prostate Cancer Early Detection

INTRODUCTION

The panel recognizes that prostate cancer represents a true spectrum of disease and that not all men diagnosed with prostate cancer require treatment. The panel believes that maximizing the detection of early prostate cancer will increase the detection of both indolent (slower-growing) and aggressive (faster-growing) prostate cancers. The challenge is to minimize immediate treatment (over-treatment) of indolent cancers by accurately characterizing the biology of the detected cancer. This guideline highlights several techniques designed to improve the identification of significant cancer while avoiding the detection of indolent disease. Identification and selective treatment of aggressive cancers should result in significant decreases in morbidity and mortality while limiting adverse effects on quality of life. The NCCN Prostate Cancer Early Detection Guidelines do not address the treatment of prostate cancer. See the [NCCN Guidelines for Prostate Cancer](#) for prostate cancer treatment recommendations. It is the intention of the panel that these guidelines be linked and, specifically, early detection strategies that do not recognize the importance of refined and selective treatment may result in harm.

The guidelines are specifically for men opting to participate in an early detection program (after receiving the appropriate counseling on the pros and cons). It is the majority opinion of the Prostate Cancer Early Detection Panel Members that there is a growing population of men currently being diagnosed with prostate cancer who can, and should, be monitored for their disease as presented in the [NCCN Guidelines for Prostate Cancer](#). The guidelines for when to start and stop screening, at what intervals to conduct screening, and when to biopsy were recommended by most panel members, but a consensus was not reached. The guidelines are continuously in a state of evolution, and the panel will incorporate changes based on new evidence and expert opinion and provide a rating of consensus for each recommendation.

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BASELINE EVALUATION

- History and physical (H&P) including:
 - ▶ Family history
 - ▶ Medications
 - ▶ History of prostate disease and screening, including prior PSA and/or isoforms, exams, and biopsies
 - ▶ Race^a
 - ▶ Family or personal history of BRCA1/2 mutations^b

RISK ASSESSMENT

Start risk and benefit discussion about offering prostate screening:

- Baseline PSA^c
- Strongly consider baseline digital rectal examination (DRE)^c

Age 45-75 y

Age >75 y, in select patients (category 2B)^d

EARLY DETECTION EVALUATION

PSA <1 ng/mL,
DRE normal (if done)

PSA 1-3 ng/mL,^e
DRE normal (if done)

PSA >3 ng/mL^e
or very suspicious DRE

PSA <4 ng/mL, DRE
normal (if done), and
no other indications
for biopsy

PSA ≥4 ng/mL or very
suspicious DRE

Repeat testing at
2–4 year intervals^f

Repeat testing at
1–2 year intervals

[See Indications
for Biopsy \(PROSD-3\)](#)

Repeat testing in
select patients at
1–4 year intervals

[See Indications
for Biopsy \(PROSD-3\)](#)

^aAfrican-American men have a higher incidence of prostate cancer, increased prostate cancer mortality, and earlier age of diagnosis compared to Caucasian-American men. This is attributable to a greater risk of developing preclinical prostate cancer and a higher likelihood that a preclinical tumor will spread. Consequently, it is reasonable for African-American men to begin discussing PSA screening with their providers several years earlier than Caucasian-American men and to consider screening at annual intervals rather than every other year.

^bIf there is a known or suspected cancer susceptibility gene, referral to a cancer-genetics professional is recommended. BRCA1/2 pathogenic mutation carriers are associated with an increased risk of prostate cancer before age 65 years, and prostate cancer in men with germline BRCA2 mutations occurs earlier and is more likely to be associated with prostate cancer mortality. Information regarding BRCA1/2 gene status should be used as part of the discussion about prostate cancer screening. [See Discussion.](#)

^cThe best evidence supports the use of serum PSA for the early detection of prostate cancer. DRE should not be used as a stand-alone test, but should be performed in those with an elevated serum PSA. DRE may be considered as a baseline test in all patients as it may identify high-grade cancers associated with “normal” serum PSA values. Consider referral for biopsy, if DRE is very suspicious. Medications such as 5α-reductase inhibitors (finasteride and dutasteride) are known to decrease PSA by approximately 50%. PSA values in these men should be corrected accordingly. Halpern JA, Shoag JE, Mittal S, et al. Prognostic significance of digital rectal examination and prostate specific antigen in the prostate, lung, colorectal and ovarian (PLCO) cancer screening arm. *J Urol* 2017;197:363-368.

^dTesting above the age of 75 years of age should be done with caution and only in very healthy men with little or no comorbidity as a large proportion may harbor cancer that would be unlikely to affect their life expectancy, and screening in this population would substantially increase rates of over-detection. However, a clinically significant number of men in this age group may present with high-risk cancers that pose a significant risk if left undetected until signs or symptoms develop. Very few men above the age of 75 years benefit from PSA testing.

^eThe reported median PSA values for men aged 40–49 y range from 0.5–0.7 ng/mL, and the 75th percentile values range from 0.7–0.9 ng/mL. Therefore, the PSA value of 1.0 ng/mL selects for the upper range of PSA values. Men who have a PSA above the median for their age group are at a higher risk for prostate cancer and for the aggressive form of the disease. The higher above the median, the greater the risk.

^fMen age ≥ 60 years with serum PSA <1.0 ng/mL have a very low risk of metastases or death due to prostate cancer and may not benefit from further testing. A PSA cut point of 3.0 ng/mL at age 75 years also carries a low risk of poor outcome.

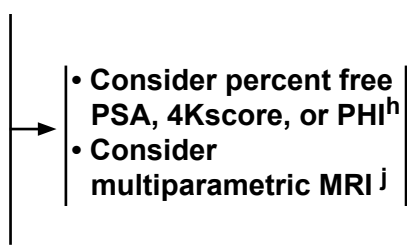
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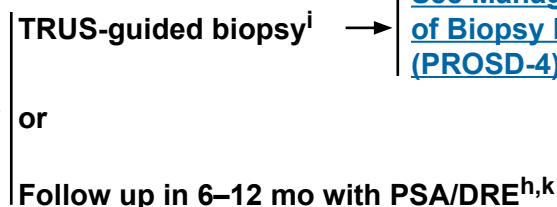


INDICATIONS FOR BIOPSY^g

- Repeat PSA
- DRE, if not performed during initial risk assessment
- Workup for benign disease



MANAGEMENT



[See Management of Biopsy Results \(PROSD-4\)](#)

TRUS-GUIDED BIOPSY
Initial and Repeat
Extended-pattern biopsy (12 cores)

- Number of cores:
 - ▶ Sextant (6),
 - ▶ Lateral peripheral zone (6), and
 - ▶ Lesion-directed at palpable nodule or suspicious image
- Anteriorly directed biopsy is not supported in routine biopsy. However, the addition of a transition zone biopsy to an extended biopsy protocol may be considered in a repeat biopsy if PSA is persistently elevated.
- Multiparametric MRI (MP MRI) followed by lesion targeting may maximize the detection of higher risk disease and limit the detection of lower risk disease.^j
- Local anesthesia can decrease pain/discomfort associated with prostate biopsy and should be offered to all patients.

^gThe level of PSA correlates with the risk of prostate cancer. The Prostate Cancer Prevention Trial (PCPT) demonstrated that 15% of men with a PSA level of ≤4.0 ng/mL and a normal DRE had prostate cancer diagnosed on end-of-study biopsies. Approximately 30% to 35% of men with serum PSA between 4 to 10 ng/mL will be found to have cancer. Total PSA levels >10 ng/mL confer a greater than 67% likelihood of prostate cancer.

^hBiomarkers that improve the specificity of detection are not, as yet, recommended as firstline screening tests. However, there may be some patients who meet PSA standards for consideration of prostate biopsy, but for whom the patient and/or the physician wish to further define the probability of high-grade cancer. A percent free PSA <10%, PHI >35 or 4Kscore (which provides an estimate of the probability of high-grade prostate cancer) are potentially informative in patients who have never undergone biopsy or after a negative biopsy; a PCA3 score >35 is potentially informative after a negative biopsy. The predictive value of the serum biomarkers discussed above has not been correlated with that of MRI. Therefore it is not known how such tests could be applied in optimal combination.

ⁱFor patients with abnormal DRE, biopsy or additional testing should be considered based on concern for cancer.

^jEmerging data suggest that, in men undergoing initial biopsy, targeting using MRI/ultrasound fusion may significantly increase the detection of clinically significant, higher-risk (Gleason grade ≥ 4+3=7) disease while lowering the detection of lower-risk (Gleason sum 6 or lower-volume Gleason grade 3+4=7) disease. Siddiqui M, Rais-Bahrami S, Turkbey B, et al. Comparison of MRI/Ultrasound Fusion–Guided Biopsy With Ultrasound-Guided Biopsy for the Diagnosis of Prostate Cancer. JAMA 2015;313:390-7. Ahmed H, Bosaily A, Brown L, et al. Diagnostic accuracy of multi-parametric MRI and TRUS biopsy in prostate cancer (PROMIS): a paired validating confirmatory study. Lancet 2017;389:815-822.

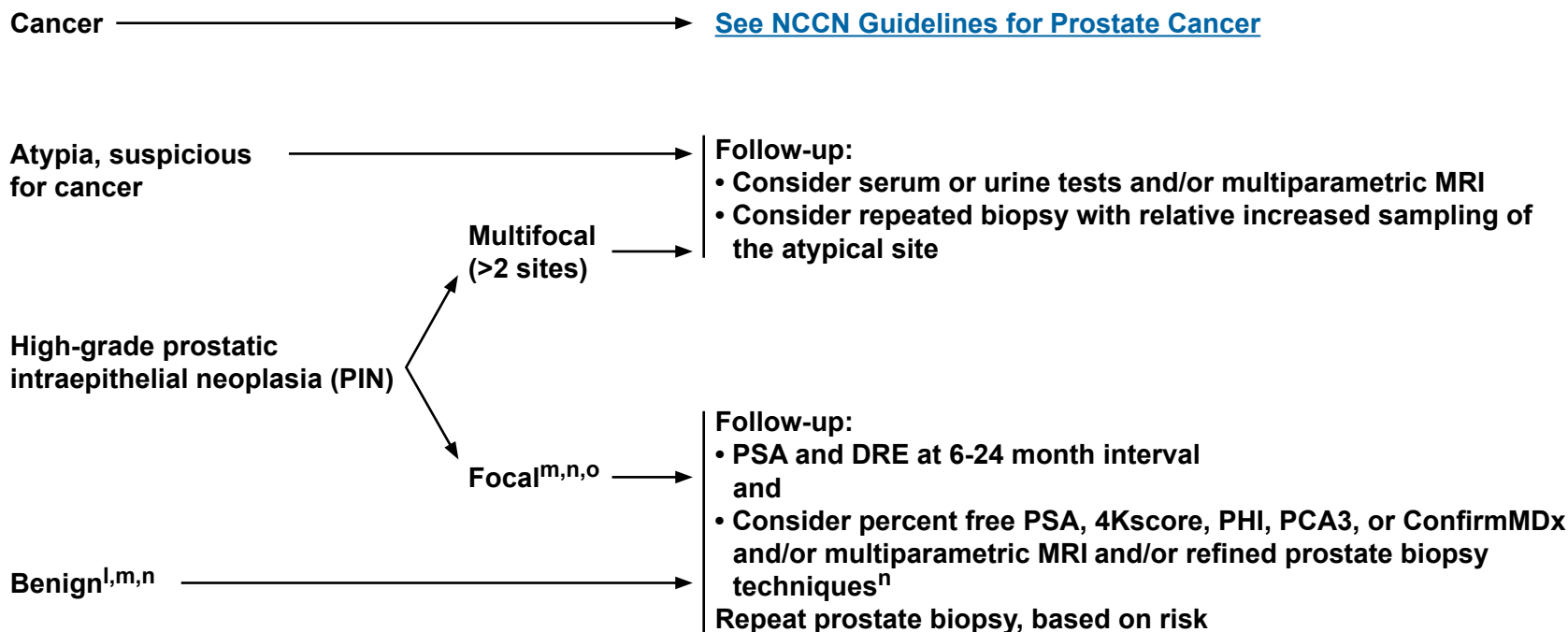
^kPatients with a persistent and significant increase in PSA should be encouraged to undergo TRUS-guided biopsy.

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.



MANAGEMENT OF BIOPSY RESULTS



^lIt is well known that a negative prostate biopsy does not preclude a diagnosis of prostate cancer on subsequent biopsy. Those patients with negative prostate biopsies should be followed with DRE and PSA. Tests that improve specificity in the post-biopsy state—including 4Kscore, PHI, percent free PSA, PCA3, and ConfirmMDx—should be considered in patients thought to be higher risk despite a negative prostate biopsy ([See PROSD-3](#)).

^mPSA testing may be discontinued at certain ages and PSA cutpoints, as noted in the [discussion section](#).

ⁿEmerging evidence suggests that use of multiparametric MRI and/or use of refined prostate biopsy techniques (image guidance using MRI/ultrasound fusion, transperineal, or saturation prostate biopsies) may be of value. These techniques may help identify regions of cancer missed on prior prostate biopsies and should be considered in selected cases after at least 1 negative prostate biopsy. Multiparametric MRI followed by lesion targeting may maximize the detection of higher risk disease and limit the detection of lower risk disease.

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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.



NCCN Guidelines Version 1.2017 Prostate Cancer Early Detection

Discussion

This discussion is being updated to correspond with the newly updated algorithm. Last updated 04/28/16

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 noted.

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Introduction

Prostate cancer represents a spectrum of disease that ranges from non-aggressive, slow-growing disease that may not require treatment to aggressive, fast-growing disease that does. The NCCN Guidelines for Prostate Cancer Early Detection provide a set of sequential recommendations detailing a screening and evaluation strategy for maximizing the detection of prostate cancer that is potentially curable and that, if left undetected, represents a risk to the patient.

These guidelines focus on minimizing unnecessary procedures and limiting the detection of indolent disease. These guidelines were developed for men who have elected to participate in the early detection of prostate cancer. The panel does not support unselected and uninformed population-based screening. The panel supports screening only in healthy men. Any clinician who uses these guidelines is expected to exercise independent medical judgment in the context of individual clinical circumstances, and to fully incorporate patient preferences in deciding how to apply these guidelines.

Overview

Prostate cancer is the most commonly diagnosed cancer and the second leading cause of cancer deaths in American men. In 2016, it is estimated that 180,890 men will be diagnosed with prostate cancer and 26,120 will die of this disease.¹ During the same period, nearly 20 million men in the United States will be confronted with important decisions regarding early detection for prostate cancer. Men in the United States have about one chance in 7 of eventually being diagnosed with this malignancy and about one chance in 30 of eventually dying of it.²

By 2015, death rates for prostate cancer in the United States had fallen 47% from peak rates, largely due to early detection and improved treatment.³

The panel supports the continued use of prostate-specific antigen (PSA) testing for the early detection of prostate cancer in informed, healthy men in certain age groups. The panel bases this recommendation on level I evidence from randomized trials that observed a reduction in prostate cancer-specific mortality in men who underwent PSA screening. However, the panel also uniformly acknowledges the risk of over-detection of otherwise indolent disease and the attendant risk of overtreatment, which exposes men to the potential morbidity of treatment without benefit. Therefore, these guidelines highlight several techniques designed to improve the identification of significant cancer while avoiding the detection of indolent disease. The panel also concludes that these NCCN Guidelines for Prostate Cancer Early Detection should be used in conjunction with the NCCN Guidelines for Prostate Cancer (available at www.NCCN.org), which explicitly recommends active surveillance or observation for appropriate candidates.

Literature Search Criteria and Guidelines Update Methodology

Prior to the update of this version of the NCCN Guidelines for Prostate Cancer Early Detection, an electronic search of the PubMed database was performed to obtain key literature in the field of prostate cancer published between August 6, 2014 and September 18, 2015, using the following search terms: (prostate cancer) AND (screening OR early detection). The PubMed database was chosen because it remains the most widely used resource for medical literature and indexes only peer-reviewed biomedical literature.⁴

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; Validation Studies; and Systematic Reviews.

The PubMed search resulted in 197 citations, and their potential relevance was examined. The data from key PubMed articles and articles from additional sources (eg, e-publications ahead of print, meeting abstracts) deemed as relevant to these Guidelines and discussed by the panel have been included in this version of the Discussion section. 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 on the NCCN website (www.NCCN.org).

Types of Early Detection Testing

PSA Testing

PSA is a glycoprotein secreted by prostatic epithelial cells, and its protease activity lyses the clotted ejaculate to enhance sperm motility. Although primarily confined to the seminal plasma, PSA enters the circulation through unknown mechanisms. Many commercially available sources of PSA antibodies for serum tests are available worldwide. With the exception of minor differences in the calibration of these assays, they perform comparably when used appropriately. However, PSA measures obtained using different commercial assays are not directly comparable or interchangeable, since the values are calibrated against different standards. If an abnormally high PSA is observed, repeat testing should be performed, particularly if the value is close to the

threshold. One study showed that approximately 25% of men with initial PSA levels between 4 and 10 ng/mL had normal PSA values upon repeat testing.⁵

PSA is not a cancer-specific marker, and as such most men with elevated PSA levels do not have prostate cancer. In fact, only about 25% of men with PSA in the 4 to 10 ng/mL range have a subsequent positive biopsy.⁶ Still, men with low PSA values have a significant chance of having prostate cancer. Using data from 18,882 men in the Prostate Cancer Prevention Trial (PCPT), Thompson et al⁷ determined the sensitivity and specificity of PSA levels for detecting any prostate cancer using various cut-offs. At 3.1 ng/mL, PSA has a sensitivity of about 32% and a specificity of about 87%.

Despite its limitations, recent population-based prostate cancer screening studies have demonstrated survival benefits using PSA—sometimes in combination with DRE or other ancillary tests, as discussed in more detail below.

Factors Affecting PSA Levels

PSA can be elevated due to infection, recent instrumentation, ejaculation, or trauma. However, empiric antibiotic use appears to have little value for improving test performance in asymptomatic men with an elevated PSA.⁸

The 5 α -reductase inhibitors (5-ARI) finasteride and dutasteride are commonly used to treat lower urinary tract symptoms due to benign prostatic hyperplasia (BPH). Use and duration of 5-ARI therapy should be elicited carefully in the history, because this class of drugs typically results in an approximate 50% decrease in serum PSA levels within 6 to 12 months of initiating therapy.⁹ However, this effect is tremendously variable. For example, one study showed that after 12 months of

treatment, only 35% of men demonstrated the expected 40% to 60% decrease in PSA, while another 30% had greater than a 60% decrease.¹⁰ Thus, the commonly employed method of doubling the measured PSA value to obtain an adjusted value may result in unreliable cancer detection.

In fact, failure to achieve a significant PSA decrease while taking 5-ARIs can indicate a heightened risk for prostate cancer that warrants regular testing. Results from several clinical trials suggested that 5-ARIs enhance the predictive capacity of PSA,^{11,12} but reflex ranges for PSA among patients on 5-ARIs have not been established. The PCPT of 18,882 men demonstrated that finasteride reduced the incidence of prostate cancer by 25% compared to placebo. This reduction was almost exclusively for low-grade (Gleason sum 6) tumors; an increased proportion of aggressive (Gleason sum ≥ 7) tumors was seen.¹³ However, after 18 years of follow-up, there was no significant group difference in overall survival or survival after the diagnosis of prostate cancer in those on finasteride compared to the control group.¹⁴

In the Reduction by Dutasteride of Prostate Cancer Events (REDUCE) trial, PSA detected more high-grade tumors in the dutasteride arm, while the overall prostate cancer diagnosis fell by 23% compared to control.¹² Similar to the PCPT trial, the difference in the number of high-grade cancers detected did not result in a mortality difference.¹⁵

A report on the Combination of Avodart (dutasteride) and Tamsulosin (CombAT) trial also showed a 40% lower incidence of prostate cancer with dutasteride plus tamsulosin (another BPH drug) compared to tamsulosin alone, along with a slightly improved yield of PSA-driven biopsy.¹⁶ Unlike the PCPT and REDUCE studies, diagnosis of high-grade (Gleason sum ≥ 7) tumors was not increased. Overall, these studies suggest that PSA testing may have enhanced specificity for

men receiving finasteride or dutasteride. Whether or not men should consider taking these agents for chemoprevention is beyond the scope of this guideline.

Ketoconazole, commonly used to treat fungal conditions, inhibits the androgen synthesis pathway and hence can also lower PSA levels. Since moderate PSA decreases have been observed with ketoconazole in the treatment of patients with prostate cancer after failure of hormonal therapy,¹⁷ recent ketoconazole use should also be noted in the history.

A health survey on 12,457 men visiting a prostate cancer screening clinic showed that over 20% of the men took herbal supplements, while only 10% took prescription medication (such as finasteride) for lower urinary tract symptoms.¹⁸ Several of these herbal supplements, such as saw palmetto, may contain phytoestrogenic compounds that can affect serum PSA levels. Very little is known about the exact composition of these herbal supplements and their specific effects on serum PSA levels.

Overall, appropriate use of PSA testing alone can provide a diagnostic lead-time of 5 to 10 years, but the lead-time varies across studies, populations, and screening protocols.¹⁹ Since the introduction of PSA testing, there has been an increase in the detection of early-stage, organ-confined disease and a decrease in disease that is metastatic at the time of diagnosis.²⁰ The risk of prostate cancer increases with increasing PSA, but there is no level of PSA below which the risk of prostate cancer can be eliminated. The PCPT demonstrated that 15% of men with a PSA level of 4.0 ng/mL or less and a normal DRE had prostate cancer (as diagnosed by end-of-study biopsies).²¹ Approximately 30% to 35% of men with serum PSAs in the 4 to 10 ng/mL range will be found to have cancer. Total PSA (tPSA) levels >10

ng/mL confer a greater than 67% likelihood of biopsy-detectable prostate cancer.²²

Controversies of PSA Testing

The decision about whether to pursue early detection of prostate cancer is complex. When, who, and how often to test remain major topics of debate.²³⁻²⁵ PSA screening has played a critical role in the downward migration of prostate cancer stage seen over the past decades. The incidence of metastatic disease at the time of diagnosis has decreased dramatically since 1988.^{26,27} As a result of early detection strategies, there has been considerable stage migration in the past 2 decades in the United States. This trend has likely, but not positively, contributed to a substantial reduction in prostate cancer mortality.^{28,29}

Still, although prostate cancer is a major cause of death and disability in the United States, many argue that the benefits of early detection are, at best, moderate, and that early detection often results in over-detection, which is the identification of indolent disease, disease that would not be a problem for the patient if undetected or untreated. These arguments hold that over-detection may lead to over-treatment, which is aggressive treatment in men with a low probability of yielding clinical benefit. In addition, PSA testing often produces false-positive results, which in turn contribute to patient anxiety and the increased costs and potential complications associated with unnecessary biopsies.

On the basis of its perception of the harm-benefit tradeoffs of prostate cancer screening, the U.S. Preventive Services Task Force (USPSTF) has recommended against routine PSA testing.³⁰ After this recommendation, prostate cancer screening decreased as did diagnoses of localized prostate cancers, whereas diagnoses of metastatic prostate cancer remained stable.³¹⁻³⁶

DRE

Best evidence supports the use of serum PSA for the early detection of prostate cancer. Still, many experts continue to recommend digital rectal examination (DRE) for screening, as some clinically significant cancers may potentially be missed using a serum PSA cut-point alone. Studies have consistently shown that prostate cancer cases detected through PSA testing are more often confined to the prostate than those detected solely by DRE.^{37,38} Currently, 81% of prostate cancers are pathologically organ-confined at time of diagnosis.³⁹

Recent screening trials have either used DRE in conjunction with PSA for screening⁴⁰ or as an ancillary test for patients who are found to have an elevated PSA.^{41,42} To elucidate the specific role of DRE in screening for prostate cancer, Gosselaar and colleagues⁴³ showed that among those with a serum PSA >3 ng/mL, those with a positive DRE were more likely to have prostate cancer. Furthermore, among 5519 men in the control arm of the PCPT, Thompson and colleagues⁴⁴ observed that an abnormal DRE increased the probability of cancer detection by almost 2.5 fold in multivariable analysis; the risk of high-grade disease was increased 2.7 fold with an abnormal DRE.

However, in men with normal PSA, the positive predictive value (PPV) of DRE is poor (about 4%–11%).^{45,46} Therefore, an abnormal DRE result alone as an indication for biopsy would lead to a large number of unnecessary biopsies and the detection of many insignificant cancers in men with low PSA values. In fact, in an analysis of 166,104 men with prostate cancer diagnosed between 2004 and 2007 from the SEER database, only 685 (0.4%) had palpable, PSA-occult (PSA level of <2.5 ng/mL), Gleason score 8-10 prostate cancer.⁴⁷

Overall, the panel believes that the value of DRE as a stand-alone test for prostate detection is limited, even though DRE picks up some cases

of advanced cancer that would otherwise be missed. Therefore, the panel believes that DRE should not be used as a stand-alone test without PSA testing. Instead, the panel recommends DRE as a complementary test that may be considered with serum PSA in asymptomatic men who had a risk/benefit discussion and decided to pursue screening for prostate cancer. Those with a very suspicious DRE should be considered for biopsy referral regardless of PSA results, because it may identify high-grade cancers in such situations. Furthermore, the panel believes that DRE should be performed in all men with an abnormal serum PSA to aid in decisions regarding biopsy (see *Pre-Biopsy Workup*, below).

Population-Based Screening Studies

Although many trials have been cited with regard to PSA testing, 2 studies are most relevant due to their topicality and randomized design.

ERSPC Trial

The ERSPC involved about 182,000 men between the ages of 50 and 74 years in 7 European countries, randomly assigned to a group that was offered PSA screening at an average of once every 4 years or to a control group that did not receive such screening; DRE or other ancillary tests were also performed in the screening group.^{42,48} The predefined core group included 162,388 men aged 55 to 69 years. Death from prostate cancer was the primary outcome. During a median follow-up of 11 years, the cumulative incidence of prostate cancer was 7.4% in the screening group versus 5.1% in the control group. There were 299 prostate cancer deaths in the screening group compared to 462 in the control group. The rate ratio for death from prostate cancer was 0.79 for the screening arm compared to the control arm (95% CI, 0.68–0.91; $P = .001$). The investigators concluded that the PSA-based screening program reduced mortality from prostate cancer by 21%. At the time of

publication, the authors stated that 1055 men would need to be screened and 37 additional men would need to be treated over 11 years to prevent one prostate cancer death. Modeling the ERSPC data, however, Heijnsdijk and colleagues⁴⁹ estimated that the number needed to screen was 98 and the number needed to treat was 5 to prevent one prostate cancer death.

A recent report of 13-year follow-up of the ERSPC trial, with 7408 cases of prostate cancer diagnosed in the screening arm and 6107 cases diagnosed in the control arm, confirmed these results.⁵⁰ The unadjusted rate ratio for death from prostate cancer was 0.79 (95% CI, 0.69–0.91) at 13 years. After adjusting for non-participation, the rate ratio of prostate cancer death was 0.73 (95% CI, 0.61–0.88). The authors reported that, for 781 men invited for screening or 27 additional prostate cancers detected, one prostate cancer death could be averted. Furthermore, another analysis of this 13-year data found that fewer men were diagnosed with metastatic disease in the screening arm (incidence rate ratio, 0.60; 95% CI, 0.52–0.70).⁵¹

The apparent risk reduction was also confirmed in a recent analysis of the Rotterdam section of the ERSPC trial where prostate cancer-specific mortality was reduced by 32%.⁵² This same group found that if one controlled for noncompliance and nonattendance, the risk of death due to prostate cancer can be reduced by up to 51%.⁵³

The Göteborg randomized population-based prostate cancer screening trial was initiated before and independently of the ERSPC, but some of its patients were reported as part of the ERSPC.⁴¹ Twenty thousand men aged 50 to 64 years were randomized to either a screening group invited for PSA testing every 2 years or to a control group not invited. The study is ongoing, with men who have not reached the upper age limit invited for PSA testing. In men randomized to screening, 76%

attended at least one test. PSA testing in the general population was very low at the beginning (3%), but increased over time.

During a median follow-up of 14 years, 1138 men in the screening group and 718 in the control group were diagnosed with prostate cancer, resulting in a cumulative prostate cancer incidence of 12.7% in the screening group and 8.2% in the control group (HR, 1.64; 95% CI, 1.50–1.80; $P < .0001$). The rate ratio for death from prostate cancer was 0.56 (95% CI, 0.39–0.82; $P = .002$) in the screening compared with the control group. Overall, 293 men needed to be screened and 12 needed to be diagnosed to prevent one prostate cancer death over 14 years. This study shows that prostate cancer screening is acceptable to the Swedish population and that prostate cancer mortality was reduced almost by half over 14 years. In addition, it should be noted that a cause-specific survival benefit was noted despite the fact that not all cancers were immediately treated. *This result suggests that early detection combined with selective treatment based on risk can lower mortality rates without uniform treatment of all cancers.*

Eighteen-year follow-up of the Göteborg trial was recently reported, with 1396 cases of prostate cancer in the screening arm and 962 cases in the control arm.⁵⁴ The reduction in absolute prostate cancer-specific mortality was 0.72 (95% CI, 0.50–0.94). The number needed to invite to prevent one death was 139 and the number needed to diagnose was 13.

There are several possible explanations for the more favorable results of the Göteborg trial compared to the PLCO (see below) or ERSPC trials. First, the patients were younger and less likely to have incurable prostate cancer at first screening; second, there was less contamination of the control arm because PSA testing was uncommon in the Swedish population when the study began; third, a lower PSA threshold was

used for recommending a biopsy; and finally, men were screened more frequently than ERSPC and for a longer period than PLCO. However, because more than half of the participants were included in the main analysis of ERSPC, the Göteborg trial should not be interpreted as a true independent confirmatory study. A recent analysis of the Göteborg trial showed that the risks of aggressive prostate cancer and prostate-cancer mortality became similar in the screening and control arms 9 years after the cessation of screening.⁵⁵

In a similar fashion, the Finnish Prostate Cancer Screening Trial, the largest component of ERSPC, reported a small, non-statistically significant reduction in prostate cancer-specific death after 12 years of follow-up.⁵⁶

PLCO Trial

The PLCO study randomized 76,685 men aged 55 to 74 years at 10 U.S. study centers to annual screening (annual PSA for 6 years and DRE for 4 years) or usual care.⁵⁷ After 13 years of follow-up, the incidence rate ratio for the screening arm compared to the control arm was 1.12 (95% CI, 1.07–1.17). The investigators did not find a statistically significant difference between the disease-specific mortality rates of the screening and control groups (RR, 1.09; 95% CI, 0.87–1.36).

Despite the large sample size, this trial was flawed both by prescreening and the high contamination rate of 40% to 52% per year in the control group (ie, 74% of men in the usual care arm were screened at least once). The estimated mean number of screening PSAs (DREs) was 2.7 (1.1) in the control arm and 5.0 (3.5) in the screened arm. In addition, the biopsy rate for those with elevated serum PSA values was relatively low compared to the European trials. The PLCO trial thus really compared fixed screening versus “opportunistic” screening and,



therefore, did not really test the hypothesis that screening with PSA is of value. However, it did show that yearly screening may be of limited value compared to less frequent testing.⁵⁸

In a subset analysis reported by Crawford and colleagues,⁵⁹ a 44% decrease in the risk of prostate cancer-specific death was observed in men with no or minimal comorbidity assigned to screening compared to control, and the numbers needed to screen and treat to prevent one death were 723 and 5, respectively. This benefit was not found among men with one or more significant comorbidities. These results suggest that screening is more useful among men in good health due to the lack of competing cause for mortality. However, others suggest that such analysis is prone to major methodological errors.⁶⁰

Trial Limitations

In addition to the limitations of the PLCO trial noted previously, these randomized controlled trials (RCTs) also share at least three additional limitations. First, they did not address the potential benefit of screening in men with high-risk factors. For instance, <5% of PLCO participants were of African-American descent and only 7% reported a family history of prostate cancer.⁴⁰ Therefore, it is not known whether men at higher risk may benefit more from screening than those at lower risk. Second, many men in these studies underwent sextant prostate biopsies rather than extended core biopsies, the standard diagnostic technique used today. The ERSPC may have underestimated benefit due to advanced age at first PSA test (median above 60), low intensity of screening (largely every 4 years) and, perhaps, suboptimal treatment available in Europe in the 1990s compared to what is available today.

The reduction in prostate cancer mortality must be balanced against the adverse effects of treatment, emphasizing the importance of selective

rather than universal treatment of men with prostate cancer identified by screening.⁴⁹

Practical Considerations of Testing

Age at Which to Initiate Testing

Controversy exists as to the ideal age to begin screening for prostate cancer. Recent randomized trials looking at the impact of screening on prostate cancer mortality have focused primarily on men aged 55 to 69 years. The ERSPC and Göteborg trials reported decreased disease-specific mortality in men aged 55 to 69 and 50 to 64 years, respectively. These results support baseline PSA testing in men aged 50 to 55 years with the strongest evidence supporting testing at age 55. A recent analysis of PSA testing in Swedish men aged 50 to 54 years supports screening in this younger cohort.⁶¹

As even younger men were not included in these screening studies, baseline testing at earlier ages has not been evaluated in RCTs. However, observational evidence suggests that baseline testing of men in their 40s and early 50s may have value for future risk stratification, although some would describe the value as marginal.⁶² A study by Lilja and colleagues⁶³ assessed blood collected from 21,277 men in Sweden aged 33 to 50 years who were followed until 2006. Among the 1312 cases of prostate cancer and 3728 controls without prostate cancer, these investigators reported that a single PSA test before age 50 years predicted subsequent prostate cancer up to 30 years later with a robust area under the curve (AUC) of 0.72 (0.75 for advanced prostate cancer).

A recent report clarified associations of age with the long-term risks of metastases.⁶⁴ In this study, the risk of prostate cancer death was strongly correlated with baseline PSA in men aged 45 to 49 years and

51 to 55 years; 44% of the deaths in the analytic cohort occurred in men in the highest tenth of the distribution of PSA, suggesting that there may be a strong rationale for baseline testing in men younger than age 55 years.

Taken together, these results suggest that one could perform early baseline testing and then determine the frequency of testing based on risk. Although many advocate earlier testing only in men thought to be at higher risk due to family history or race, a baseline serum PSA is a stronger predictor of the future risk of the disease compared to either of these risk factors.

Most panel members favor informed testing beginning at age 45 years. Repeat testing at 1- to 2-year intervals is recommended for men who have a PSA value ≥ 1.0 ng/mL and at 2- to 4-year intervals for men with PSA < 1 ng/mL (also see *Frequency of Testing*, below). This value is above the 75th percentile for younger men (< 50 years).⁶⁵ The median PSA levels are 0.7 ng/mL and 0.9 ng/mL for ages 40 to 49 and ages 50 to 59, respectively.^{66,67}

Frequency of Testing

Current guidelines and recent screening trials have employed varying strategies with regards to the frequency of prostate cancer screening. The ideal screening interval to maximize mortality reduction yet minimize overdiagnosis remains uncertain.

A recent comparison of two centers involved in the ERSPC trial studied the impact of different screening intervals on the diagnosis of interval cancers in men aged 55 to 64 years.⁶⁸ The Göteborg arm randomized 4202 men to screening every 2 years, while the Rotterdam arm randomized 13,301 men to screening every 4 years with similar follow-up of 11 to 12 years. Compared to screening every 4 years, there was a

significant 43% reduction in the diagnosis of advanced prostate cancer (clinical stage $> T3a$, N1, or M1; PSA > 20 ng/mL; Gleason > 8 at biopsy) for screening every 2 years. However, there was also a 46% increase in the diagnosis of low-risk prostate cancer (clinical stage T1c, Gleason < 6 , and PSA < 10 ng/mL at biopsy) for screening every 2 years.

Another study using micro-simulation models of prostate cancer incidence and mortality predicted that a strategy that utilizes biennial intervals in men with average PSA levels and longer screening intervals (every 5 years) for men with low PSA levels (below median for age by decade) allows a 2.27% risk of prostate cancer death compared to 2.86% from no screening.⁶⁹ In addition, compared to annual screening and using a biopsy threshold of 4.0 ng/mL, the biennial strategy also projected a relatively lower over-diagnosis rate of 2.4% (vs. 3.3% for annual screening), 59% reduction in total tests, and a 50% reduction in false-positive results. The biennial model was robust to sensitivity analyses, which varied the range of cancer incidence and survival attributed to screening.

Few studies have addressed the effect of PSA levels on the interval of testing, but it appears that men with a very low PSA could safely extend the testing interval. In the Rotterdam section of the ERSPC trial, men with a PSA < 1 ng/mL had a very low risk for cancer at 4 and 8 years (0.23% and 0.49%).⁷⁰ Other studies have shown that PSA values at younger ages strongly predict the development of or death from prostate cancer.^{67,71} For example, in a Swedish case-control study of 1167 men, those aged 60 years with PSA concentrations of ≤ 1 ng/mL had only a 0.5% risk of metastasis by age 85 and 0.2% risk of death from prostate cancer.⁷¹

After considering these data, the panel concluded that tailoring screening intervals based on PSA levels might maximize survival



advantage while decreasing the number of screenings and limiting over-diagnosis. The panel recommends repeat testing every 2 to 4 years if PSA is <1 ng/mL and every 1 to 2 years if PSA is 1 to 3 ng/mL in men aged 45 to 75 years. The panel notes that a younger man on the higher end of PSA (eg, a 45-year-old man with PSA 0.9 ng/mL) might be screened in 2 years, whereas an older man with a lower PSA might be screened in 4 years. Clinical judgment should be used.

Age at Which to Discontinue Testing

Even more elusive than identifying the ideal age at which to start screening is determining the ideal age at which to discontinue screening for men with normal PSA levels.

Panelists uniformly agreed that PSA testing should only be offered to men with a 10 or more year life expectancy. However, panelists did not agree as to when to discontinue routine testing in asymptomatic older men. Furthermore, estimates of life expectancy can be refined using several resources such as life insurance tables.⁷²⁻⁷⁴ Physicians may not be accurate at estimating life expectancy and many tend to over-value age and under-value comorbidity.^{75,76}

Since the previously cited RCTs (ERSPC, PLCO, and Göteborg) observed benefits to testing only in men aged up to 70 years, several panelists favored stopping testing at age 70 years.

However, other data would suggest a benefit to screening beyond 70 years. A study of 4561 men who underwent radical prostatectomy found that men older than 70 years were more likely to have higher grade and stage of disease and worse survival compared to their younger counterparts.⁷⁷ Others have published similar findings.⁷⁸

To assess the appropriate ages for discontinuing screening, the previously cited micro-simulation model⁶⁹ predicted that decreasing the stopping age from 74 to 69 years would lead to a 27% relative reduction in the probability of life saved, but an almost 50% reduction in the probability of over-diagnosis. This latter finding reflects the fact that a large proportion of men older than 70 years have cancer that would be unlikely to diminish their life expectancy, and that screening in this population would substantially increase rates of over detection, while also recognizing the increased prevalence of higher-risk cases in this age that could benefit from earlier detection.

The micro-simulation model also assessed a strategy of screening men up to age 74 years while simultaneously increasing the PSA threshold for biopsy based on age-dependent PSA levels (ie, increasing the threshold level for biopsy with increasing age). Compared to using a uniform cut-off of 4.0 ng/mL, this strategy reduced the rate of over-diagnosis by one third while only slightly altering lives saved.

tPSA at certain ages may predict future risk. Vickers and colleagues⁷¹ examined the relationship between baseline PSA at age 60 years and the future risk of prostate cancer death or metastases and found that those with PSA level below the median (<1 ng/mL) were unlikely to develop clinically significant prostate cancer (0.5% risk of metastases and 0.2% risk of prostate cancer death) and may not need further testing. Similarly, in a study of 849 men in the Baltimore Longitudinal Study of Aging (BLSA), no men aged 75 to 80 years with a PSA <3.0 ng/mL died of prostate cancer.⁷⁹ Moreover, the time to death or diagnosis of aggressive prostate cancer was longer in men with a PSA <3.0 ng/mL versus those with a PSA >3.0 ng/mL, suggesting that men 75 years or older with a PSA <3.0 ng/mL are unlikely to die or experience aggressive prostate cancer throughout their remaining life and may safely discontinue screening.

In summary, many possible strategies to reduce overdiagnosis in the older population exist. At this time, the panel supports screening in men until age 75, and then continuing screening only in very select patients (category 2B). The panel notes that although some men in this older age group present with high-risk disease, very few men older than age 75 years benefit from PSA screening.

Screening in High-Risk Populations

African-American men and men with a first-degree relative with prostate cancer (especially cancer found at a younger age) have a higher risk of developing prostate cancer.⁸⁰⁻⁸⁵ In fact, having a first-degree relative with prostate cancer diagnosed before the age of 60 increases the likelihood of a prostate cancer diagnosis by 2.1- to 2.5-fold.^{83,84} Data, however, suggest that prostate cancer in men with a family history of prostate cancer is not more likely to be aggressive, and cancer-specific outcomes are similar between those with and without a family history.⁸⁵⁻⁸⁷

African-American men have a 64% higher incidence of prostate cancer and 2.3-fold increase in prostate cancer mortality compared with Caucasian men.^{80,88} Furthermore, autopsy data indicate that prostate cancer may undergo transformation to aggressive disease earlier in African-American men than in white men.⁸⁸ In addition, data suggest that African-American men have an earlier onset of prostate cancer. An analysis of SEER data from 2010 found that non-Hispanic black men are diagnosed with prostate cancer an adjusted average of 1.2 years earlier than non-Hispanic white men⁸⁹; whereas an older SEER analysis found that African-American men were diagnosed at an average of 3 years younger than white men.⁹⁰ A retrospective, population-based cohort study in the United Kingdom found that black men were diagnosed an adjusted average of 5.1 years earlier than white men.⁹¹

Another study estimated that African-American men have an almost 2-fold higher risk of being diagnosed with prostate cancer before the age of 45 than white men.⁹⁰ In addition, a recent study of 41,250 men in the Veterans Affairs (VA) Health Care System database found that the optimal PSA threshold for predicting the diagnosis of prostate cancer within 4 years was lower in African-American men than in Caucasian men (1.9 ng/mL vs. 2.5 ng/mL).⁹²

Factors that contribute to this racial disparity may include differences in genetic risk factors, environmental exposures, and patient and physician behaviors; decreased access to high-quality health care including cancer early detection and follow-up care; delays in diagnosis; and suboptimal treatment.⁹³⁻⁹⁷

Whereas it is clear that African-American men and men with a family history of prostate cancer are at higher risk for prostate cancer incidence and mortality, the effects of earlier or more intensive screening on cancer outcomes and on screening-related harms in these populations are not clear. Prostate cancer screening has been best studied in Caucasian men; data on screening in diverse and high-risk populations are lacking. In the PLCO trial, approximately 4.4% of the participants were African American and 6.9% had a positive family history, but no subset analyses were performed.⁴⁰ In the ERSPC trial, no information on race or family history was reported.⁴²

In conclusion, African-American men and men with a family history of prostate cancer represent high-risk groups. However, the panel believes that current data are insufficient to inform the best strategy for prostate cancer screening in these populations and also note that a baseline PSA value is a stronger predictive factor than a positive family history or race.⁹⁸ Therefore, although these individuals may require a higher level of vigilance and potentially different considerations when analyzing the

results of screening tests, the panel does not give separate screening recommendations for these men at this time. Race is, however, included as a baseline evaluation factor for risk assessment that can be used to help decide when a man should begin the early detection process within the NCCN-recommended ages of 45 to 75 years.

Prostate Cancer Risk in Genetic Syndromes

Some inherited syndromes increase the risk for prostate cancer. For example, men with Lynch syndrome (germline mutations in *MLH1*, *MSH2*, *MSH6*, *PMS2*, or *EPCAM*) have a 2- to 5-fold increase in risk for prostate cancer.⁹⁹⁻¹⁰³ Age of onset and aggressiveness of prostate cancer in these individuals, however, do not appear to be different than in sporadic cases.¹⁰⁰ Currently, the NCCN Guidelines for Genetic/Familial High-Risk Assessment: Colorectal (available at www.NCCN.org) do not list any specific prostate cancer screening recommendations for men with Lynch syndrome.

Germline *BRCA1* and *BRCA2* mutations (associated with hereditary breast and/or ovarian cancer syndrome) have been associated with an increased risk for prostate cancer in numerous reports.¹⁰⁴⁻¹¹² 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.^{105,107,108,112-114} Furthermore, prostate cancer in men with germline *BRCA* mutations appears to have a more aggressive phenotype and is associated with significantly reduced survival times than in non-carrier patients.¹¹⁵⁻¹¹⁹

Results from the first round of screening of the IMPACT study, which enrolled men aged 40 to 69 years with germline *BRCA1/2* mutations and a control group of men with wild-type *BRCA1/2* who are related to mutation carriers, were recently reported.¹²⁰ Whereas no difference

between carriers and controls in the rate of prostate cancer detection or the PPV of biopsy for detecting cancer in men with PSA >3.0 ng/mL was evident, a significant difference was seen in the PPV of biopsy for detecting intermediate/high-grade cancer in *BRCA2* carriers with PSA >3.0 ng/mL (2.4% vs. 0.7%; $P = .04$). Future rounds of screening in this trial may help inform the best strategy for screening in this high-risk population.

The NCCN Guidelines for Genetic/Familial High-Risk Assessment: Breast and Ovarian (available at www.NCCN.org) recommend that men with *BRCA2* mutations start prostate cancer screening at age 40 and that men with *BRCA1* mutations consider the same. However, at this time, the NCCN Prostate Cancer Early Detection panel believes that data supporting a change in the PSA screening and biopsy recommendations for men with germline *BRCA1/2* mutations relative to men without mutations are insufficient. The panel recommends inquiring about known *BRCA1/2* mutations in the family. If there is a known or suspected cancer susceptibility gene, referral to a cancer-genetics professional is recommended. Information regarding *BRCA1/2* gene status should be used as part of the discussion about prostate cancer screening; patients may not be aware of the increased risk for prostate cancer associated with such mutations.

Indications for Biopsy

The previously cited RCTs used PSA thresholds to prompt a biopsy. PSA cut-points for biopsy varied somewhat between centers and trials over time. Although a serum PSA of 2.5 ng/mL has been used by many, a level of 3 ng/mL is supported by the trials and would more robustly limit the risk of over-detection. However, some panel members did not recommend limiting the option of biopsy to pre-specified PSA thresholds, noting that there are many other factors (eg, age, race,

family history, PSA kinetics) that should also inform the decision to perform biopsy.

The panel does not believe that DRE alone should be an absolute indication for biopsy in men with low PSA. The PPV of DRE in men with low PSA is poor (see *DRE*, above).^{46,121} However, a very suspicious DRE could be an indication of high-grade cancer in men with normal PSA values, and therefore biopsy can be considered. Clinical judgment should be used.

Pre-Biopsy Workup

The panel recommends that any man with a PSA >3 ng/mL undergo workup for benign disease, a repeat PSA, and a DRE to inform decisions about whether to proceed with TRUS-guided biopsy. A DRE in this setting of elevated PSA has a high predictive value,⁴³ and the panel strongly recommends biopsy in these men. The roles of imaging and biomarker testing are discussed below.

Risk Calculators

Prostate cancer risk calculators have been developed to estimate an individual's risk for prostate cancer from multiple factors. Common calculators are the Sunnybrook-, ERSPC-, and PCPT-based risk calculators.^{44,122-126} These online tools combine clinical variables—including but not limited to age, family history, race, DRE, and PSA—to estimate both the risk for biopsy-detectable prostate cancer and the risk for biopsy-detectable high-grade prostate cancer. Such information potentially allows for more informed decision-making.¹²⁷ However, such calculators have not been assessed in RCTs, and cut-points of risk associated with reductions in prostate cancer mortality remain unknown. Such calculators have as much value in determining who might not need biopsy as in identifying those at higher risk. At this time, the panel does not recommend the use of risk calculators alone to determine

whether biopsy is indicated. Clinical judgment and patient preferences need to be taken into consideration.

Imaging

The Prostate Imaging Reporting and Data System (PI-RADS) from the American College of Radiology gives recommendations for high-quality MRI in prostate cancer care, including recommendations related to the use of MRI to direct targeted biopsies.¹²⁸ In addition, the European Society of Urogenital Radiology established guidelines for optimal multiparametric MRI of the prostate, including for detection and targeted biopsies.¹²⁹ Overall, the panel emphasizes the need for high-quality MRI and for radiologic expertise for optimal reading of scans.

Novel Imaging Techniques

There is considerable interest in the use of novel MRI imaging, most notably multiparametric MRI, to select those who need a prostate biopsy or to guide needle placement during the biopsy, although data supporting its use are limited.¹³⁰⁻¹³⁶ The goals of using MRI to inform the decision to perform biopsy include reducing the number of men undergoing biopsy, reducing the detection of indolent disease (and thus the risks of overdiagnosis and overtreatment), and improving the detection of clinically significant disease through targeted biopsies. Current data, however, do not conclusively show that MRI achieves these goals in the initial biopsy setting.

In a prospective study of 223 biopsy-naïve men with elevated PSA, all men had standard transrectal ultrasound (TRUS) biopsies in addition to multiparametric MRI.¹³² Participants with suspicious or equivocal lesions (PI-RADS 3-5) then underwent MRI-guided biopsy. TRUS biopsies detected 126 of 142 cases of cancer (88.7%) including 47 cases classified as low risk. The MRI-guided biopsies identified an additional

16 cases of intermediate/high-risk prostate cancer and led to the reclassification of 13 cases from low risk to intermediate/high risk. Thus, the addition of multiparametric MRI with targeted biopsies for suspicious or equivocal lesions to standard biopsy allowed the identification of clinically significant disease in an additional 13% of the study population. The authors also determined the effects of using multiparametric MRI to decide whether to biopsy. Not biopsying men with PI-RADS 1/2 would reduce the number of men requiring biopsy by 36%, reduce the identification of low-risk prostate cancer by 87%, and increase the yield of intermediate/high-risk tumors by 18%, but would have missed 15 intermediate/high-risk tumors (6.7% of study population).

A single-center trial randomized 130 biopsy-naïve men to a control group that received TRUS-guided random biopsy alone or to a group that received prebiopsy multiparametric MRI, TRUS-guided random biopsy, and cognitive MRI/TRUS fusion targeted biopsy.¹³⁴ The primary outcome was not met, with similar rates of detection of prostate cancer (64% vs. 57%; $P = .5$) and of clinically significant cancer (55% vs. 45%; $P = .8$) in the two arms.

In a prospective cohort study of 1003 men with elevated PSA or abnormal DRE and lesions visible on multiparametric MRI undergoing both MRI/ultrasound (US) fusion-targeted targeted and standard biopsy, Siddiqui and colleagues noted that the targeted biopsy strategy was associated with increased detection of high-risk (Gleason sum $\geq 4 + 3$) cancer and decreased detection of low-risk (Gleason sum 6 or low-volume $3 + 4 = 7$) cancer.¹³⁷ Additional clinical trials are underway to assess the value of MRI imaging for diagnosis in the pre-biopsy setting (eg, NCT02131207).

At this time, the panel strongly believes that MRI alone should not be used to decide whether to biopsy and emphasizes that a negative MRI is not an indication to forego biopsy in a man with indications for first-time biopsy. All men with indications for biopsy should receive the standard 12-core TRUS-guided biopsy regardless of MRI results. Based on the studies described above, it is estimated that the use of MRI to exclude men from biopsies may lead to as many as 12% of significant cancers being missed, although the available data to date are not conclusive.

The panel also does not uniformly recommend that MRI-guided targeted biopsies be used in place of or in addition to standard 12-core TRUS biopsies in the initial biopsy setting (see *Targeted Biopsy Techniques for Initial Biopsy*, below). More information is needed in such a setting. However, the panel believes that multiparametric MRI may help identify regions of cancer missed on prior biopsies and should be considered in selected cases of men with at least 1 negative biopsy (also see *Repeat Biopsies*, below).

Biomarker Testing: PSA Derivatives and Other Tests

When the first recommendations for early detection programs for prostate cancer were made, serum tPSA was the only PSA-based test available. PSA derivatives and other assays exist that potentially improve the specificity of testing and thus may diminish the probability of unnecessary biopsies.

When a patient meets the standards for biopsy, sometimes the patient and physicians wish to further define the probability of cancer before proceeding to biopsy with its associated risks (see *Risks of Biopsy*, below). Several biomarker tests have been developed with the goals of refining patient selection for biopsies, decreasing unnecessary biopsies, and increasing the specificity of cancer detection, without missing a

substantial number of higher-grade (Gleason ≥ 7) cancers. These tests may be especially useful in men with PSA levels between 3 and 10 ng/mL. Most often, these tests have been used in patients who have had one negative biopsy to determine if repeat biopsy is an appropriate consideration.

The panel recommends consideration of percent free PSA (%f PSA), Prostate Health Index (PHI), and 4Kscore®, in patients with PSA levels >3 ng/mL who have not yet had a biopsy. %f PSA, PHI, 4Kscore, PCA3, and ConfirmMDx may also be considered for men who have had at least one prior negative biopsy and are thought to be at higher risk.

Head-to-head comparisons have been performed in Europe for some of these tests, used independently or in combinations in the initial or repeat biopsy settings, but sample sizes were small and results varied.¹³⁸⁻¹⁴⁸ Therefore, the panel believes that no biomarker test can be recommended over any other at this time. Furthermore, a biomarker assay can be done alone or in addition to multiparametric MRI/refined biopsy techniques in the repeat biopsy setting (discussed below). The optimal order of biomarker tests and imaging is unknown; and it remains unclear how to interpret results of multiple tests in individual patients—especially when results are contradictory. Results of any of these tests, when performed, should be included in discussions between clinician and patient to assist in decisions regarding whether to proceed with biopsy. These and other tests are discussed below.

Age- and Race-Specific PSA Reference Ranges

Age-specific PSA reference ranges were introduced by Oesterling and colleagues¹⁴⁹ as a method to increase cancer detection (ie, increase sensitivity) in younger men by lowering PSA cutoffs for biopsy and to decrease unnecessary biopsies (ie, improve specificity) in older men by increasing PSA cutoffs.¹⁴⁹⁻¹⁵¹ Several groups have investigated these

age-specific ranges with equivocal results. Others have suggested race-specific reference ranges.¹⁵² However, the exact roles of these age- and race-specific PSA cutoffs in the early detection of prostate cancer remain unclear. The panel has no recommendations regarding routine use of these ranges.

PSAV

The rate of change in PSA over time is broadly termed PSA velocity (PSAV), determined by at least 3 separate PSA values calculated over at least an 18-month period. Carter and colleagues¹⁵³ first showed that PSAV is greater in men eventually diagnosed with prostate cancer than in men not diagnosed with the disease and suggested its use as a screening tool. In a subsequent study of 980 men enrolled in the BLSA, Carter and colleagues explicitly linked PSAV with the risk of prostate cancer death by observing that PSAV recorded 10 to 15 years before cancer diagnosis (commonly with PSA <4 ng/mL) was associated with disease-specific survival up to 25 years later: the relative risk of prostate cancer death was higher in men with PSAV >0.35 ng/mL/y compared to those with PSAV ≤ 0.35 ng/mL/y (RR, 4.7; 95% CI, 1.3–16.5; $P = .02$).¹⁵⁴ These data provide support that PSAV may help identify lethal cases. However, the small number of deaths from prostate cancer (20) precludes definitive conclusions.

In two other studies of men with prostate cancer,^{155,156} very high PSAV (>2 ng/mL/y) during the year before diagnosis was associated with a greatly increased risk of death from the disease, but this is a much higher cutoff for PSAV than the one proposed by Carter and colleagues.

Vickers and colleagues,¹⁵⁷ however, have questioned the role of PSAV in tumor detection among men with low PSA levels. The analysis was performed on 5519 men undergoing biopsy regardless of indication in the control arm of the PCPT to explore the additional yield from a PSAV

threshold of 0.35 ng/mL/y. The main finding of this study was that PSAV did not significantly increase the predictive accuracy of high PSA levels or positive DRE and might substantially increase the number of men recommended for biopsy. However, these findings should be applied only to men similar to those studied in PCPT (≥ 55 years of age; 96% Caucasian-American; 17% family history of prostate cancer; PSA values ≤ 3 at enrollment).⁴⁴ A recent report suggests that screening strategies that utilized PSAV at low PSA levels were more likely to suffer from overdiagnosis and false-positive tests resulting in more harm relative to incremental lives saved.⁶⁹

Panelists disagree as to the value of PSAV alone as a criterion for considering biopsy when the PSA level is low (< 2.0 ng/mL). Due to its potential capacity to identify tumors with lethal potential, most panelists agree that PSAV (PSAV ≥ 0.35 ng/mL/y) is only one criterion to consider when deciding whether to perform biopsy for men with low PSA levels. Panelists do not agree as to the threshold of PSAV that should prompt consideration of biopsy, but agree that high PSAV alone, at low PSA levels, does not mandate biopsy, but rather should aid in the decision-making process. Other factors such as age, comorbidity, race, and family history also should be considered.

In a recently reported study of men pursuing a second biopsy after an initial negative biopsy, PSAV was an independent predictor of overall prostate cancer, intermediate-grade cancer, and high-grade cancer.¹⁵⁸

Panelists would also like to draw attention to the following caveats: the predictive value of PSAV can be influenced by PSA level^{44,155,159}; PSAV is not useful in patients with very high (> 10 ng/mL) PSA values¹⁶⁰; PSAV measurements can be confounded by prostatitis, a condition that can cause dramatic and abrupt increases in PSA levels;¹⁶¹ and fluctuations among measurements can occur as a result of either

laboratory inter-assay variability related to the use of different commercially available sources or individual biological variability. Thus, an abnormal PSA result should be confirmed by retesting.

%f PSA

Unbound or free PSA (fPSA), expressed as a ratio of tPSA, is a clinically useful molecular form of PSA, with the potential to improve early detection, staging, and monitoring of prostate cancer. Several molecular forms of PSA are known to circulate in the blood. In most men, the majority (60%–90%) of circulating PSA is covalently bound to endogenous protease inhibitors. Most immunoreactive PSA is bound to the protease inhibitor alpha-1-antichymotrypsin. Other immunoreactive PSA-protease inhibitor complexes, such as alpha-1-antitrypsin and protease C inhibitor, exist at such low serum concentrations that their clinical significance has not been determined. In addition, a large proportion of PSA is complexed with alpha-2-macroglobulin (AMG). Unfortunately, this PSA-AMG complex cannot be measured by conventional assays because of the shielding (or "caging") of PSA antigenic epitopes by AMG.

Most clinical work investigating the use of the molecular forms of PSA for early detection of prostate cancer has focused on the percentage of PSA found circulating in the free or unbound form. Numerous studies have shown that the percentage of serum fPSA (%f PSA) is significantly lower in men who have prostate cancer compared with men who do not.

The FDA approved the use of %f PSA for the early detection of prostate cancer in men with a normal DRE and PSA levels between 4 ng/mL and 10 ng/mL (PSA levels where most secondary testing is done). The multi-institutional study that characterized the clinical utility of this assay showed that a 25% fPSA cutoff detected 95% of prostate cancers while avoiding 20% of unnecessary prostate biopsies.¹⁶²

Since its approval by the FDA, testing for %f PSA has gained widespread clinical acceptance in the United States, specifically for patients with normal DREs who have previously undergone prostate biopsy because they had a tPSA level within the "diagnostic gray zone."

cPSA

PSA exists in free and several complexed forms. Direct measurement of the complexed form with alpha-1-antichymotrypsin is now available. For practical purposes, tPSA consists essentially of fPSA and the alpha-1-antichymotrypsin complexed form (cPSA). The threshold levels are therefore not equivalent: cPSA levels of 2.2 ng/mL and 3.4 ng/mL are equivalent to tPSA levels of 2.5 ng/mL and 4.0 ng/mL, respectively. In a multicenter trial of 831 men, of whom 313 had prostate cancer, researchers found that cPSA in the range of 80% to 95% sensitivity thresholds increased specificity compared with tPSA.¹⁶³ Results were similar for percent cPSA and percent fPSA.

Therefore, the ratio of cPSA to tPSA should provide information comparable to the fPSA to tPSA ratio.¹⁶⁴ Other studies also demonstrated an enhanced specificity of cPSA within certain tPSA ranges.¹⁶⁵⁻¹⁶⁷ Use of cPSA has been approved as an aid in the detection of prostate cancer in men aged 50 years or older in conjunction with DRE. However, because cPSA has not gained widespread acceptance in day-to-day clinical practice, it has not been incorporated into these algorithms.

PSAD

PSA density (PSAD) requires the measurement of prostate volume by TRUS and is expressed as the PSA value (in ng/mL) divided by prostate volume (in cc).

PSAD is a means of discriminating prostate cancer from BPH: the lower the PSAD, the greater the probability of BPH.^{168,169} Thus, PSAD potentially identifies men who do not have prostate cancer but have high PSA secondary to large-volume prostates. A PSAD cutoff of 0.15 ng/mL/cc was recommended in earlier studies, which spared as many as 50% of men from unnecessary biopsies. However, some subsequent studies have reported that the 0.15 cutoff has insufficient sensitivity.¹⁷⁰

More recent studies have tried to improve upon the performance of PSAD by using cPSA¹⁷¹ or fPSA¹⁷² in the numerator or correcting the denominator for transition zone volume.¹⁷³ The clinical utility of these methodologies remains unclear.

PSAD has also been shown to correlate with prostate cancer presence and aggressiveness, and may predict adverse pathology and biochemical progression after treatment.^{174,175}

The lack of precision of measurement of both PSA and prostate volume has prevented the widespread clinical acceptance of PSAD. In addition, studies have shown that %f PSA provides results comparable to PSAD in early-detection algorithms.¹⁷⁶

While the panel recognizes that PSAD may explain an elevated PSA value considered after negative biopsies, it has not incorporated PSAD into the early detection guidelines as a baseline measure because PSAD alone may offer little added benefit over other tests and requires US. Still, the panel agrees that PSAD has been clinically under-utilized and may be considered in evaluating patients, especially those who have had prior US-determined measurements of prostate volume.

PCA3

PCA3 is a noncoding, prostate tissue-specific RNA that is over-expressed in prostate cancer. Current assays quantify PCA3 over-expression in post-DRE urine specimens. PCA3 appears most useful in determining which patients should undergo a repeat biopsy.¹⁷⁷⁻¹⁸⁰ For example, in a prospective multicenter clinical study of 466 men with at least 1 prior negative prostate biopsy, a PCA3 score cutoff of 25 showed sensitivity of 78%, specificity of 57%, NPV of 90%, and PPV of 34%.¹⁷⁷ Men with a score of ≥ 25 were 4.6 times more likely to have a positive repeat biopsy than those with a score < 25 .

Results were reported from an NCI Early Detection Research Network (EDRN) validation study of the PCA3 urinary assay in 859 men scheduled for a diagnostic prostate biopsy in 11 centers.¹⁸¹ The primary outcomes were reported at a PPV of 80% (95% CI, 72%–86%) in the initial biopsy setting and a negative predictive value (NPV) of 88% (95% CI, 81%–93%) in the repeat biopsy setting. Based on the data, use of PCA3 in the repeat biopsy setting would reduce the number of biopsies by almost half, and 3% of men with a low PCA3 score would have high-grade prostate cancer that would be missed. In contrast, the risk of high-grade disease in men without prior biopsy with a low PCA3 is 13%. Thus, the panel believes that this test is not appropriate to use in the initial biopsy setting.

The FDA has approved the PCA3 assay to help decide, along with other factors, whether a repeat biopsy in men age 50 years or older with one or more previous negative prostate biopsies is necessary.

PHI

The PHI is a combination of the tPSA, fPSA, and proPSA tests.¹⁸²⁻¹⁸⁴ In a multi-center study, it was noted to have approximately double the sensitivity of fPSA/tPSA for cancer detection in those with serum PSA

concentrations between 2 and 10 ng/mL.¹⁸⁵ In addition, the PHI correlated with cancer grade and had an AUC of 0.72 for discrimination of high-grade (Gleason ≥ 7) cancer from low-grade cancer or negative biopsy. Another prospective cohort study calculated an AUC of 0.815 for the detection of high-grade (Gleason score ≥ 7) prostate cancer.¹⁸⁶ This study determined the optimal cutoff of PHI to be a score of 24, which should lead to 36% of biopsies avoided with approximately 2.5% of high-grade cancers missed.

The PHI was approved by the FDA in 2012 for use in those with serum PSA values between 4 and 10 ng/mL.

4Kscore®

The 4Kscore test is another combination test that measures free and tPSA, human kallikrein 2 (hK2), and intact PSA and also considers age, DRE results, and prior biopsy status.^{187,188} This test reports the percent likelihood of finding high-grade (Gleason ≥ 7) cancer on biopsy. A prospective multi-institutional U.S. trial of 1012 patients showed that 4Kscore results have a high discrimination value (AUC, 0.82).¹⁸⁹ In this study, using a threshold for biopsy of $\geq 15\%$ risk allowed for 591 biopsies to be avoided (58%), while 183 high-grade tumors were detected and 48 high-grade tumors (4.7% of the 1012 participants) were missed. When 4Kscore was examined in 6129 men in another prospective study, the AUC was also 0.82 (95% CI, 0.80–0.84).¹⁹⁰ Using a 6% risk of high-grade cancer as a cutoff, 428 of 1000 men could avoid biopsy, with 119 of 133 high-grade cancers detected and 14 of 133 missed. A multi-center clinical utility study found a 65% reduction in prostate biopsies with use of the 4Kscore test.¹⁹¹ In addition, a correlation between 4Kscore risk category and Gleason score was seen ($P < .01$).

The 4Kscore test is not FDA approved; instead it is considered a Laboratory Developed Test through one CLIA-accredited testing laboratory in Nashville, TN. The panel consensus is that the test can be considered for patients prior to biopsy and for those with prior negative biopsy for men thought to be at higher risk for clinically significant prostate cancer. It is important for patients and their urologists to understand, however, that no cut-off threshold has been established for the 4Kscore. If a 4Kscore test is performed, the patient and his urologist should discuss the results to decide whether to proceed with a biopsy.

ConfirmMDx

ConfirmMDx is a tissue-based, multiplex epigenetic assay that aims to improve the stratification of men being considered for repeat prostate biopsy. Hypermethylation of the promoter regions of *GSTP1*, *APC*, and *RASSF1* are assessed in core biopsy tissue samples. The test, performed in one CLIA-certified laboratory, is not FDA approved.

The European MATLOC study blindly tested this assay in archived tissue from 498 men with negative biopsies who had repeat biopsies within 30 months.¹⁹² The NPV was 90% (95% CI, 87%–93%). In multivariate analysis, ConfirmMDx was predictive of patient outcome (OR, 3.17; 95% CI, 1.81–5.53). A similar validation study was performed in the United States using archived tissue from 350 men with negative biopsies who had repeat biopsies within 24 months.¹⁹³ The NPV was 88% (95% CI, 85%–91%), and the test was again found to be predictive of outcomes on multivariate analysis (OR, 2.69; 95% CI, 1.60–4.51).

The panel believes that ConfirmMDx can be considered as an option for men contemplating repeat biopsy because the assay may identify individuals at higher risk of prostate cancer diagnosis on repeat biopsy.

Biopsy Technique

Initial Biopsy

Systematic prostate biopsy under TRUS guidance is the recommended technique for prostate biopsy. Initially described as a sextant technique sampling both right and left sides from the apex, mid-gland, and base in the mid-parasagittal plane, more recently extended biopsy schemes have demonstrated improved cancer detection rates. Although no one scheme is considered optimal for all prostate shapes and sizes, most emphasize better sampling of the lateral and anterior aspects of the peripheral zone. One commonly used scheme is the 12-core biopsy scheme that includes a standard sextant as well as a lateral sextant scheme (ie, lateral apex, lateral mid-gland, lateral base). This scheme has been validated and results in enhanced cancer detection compared to sextant biopsy schemes.^{194,195}

The panel recommends an extended-pattern, at least 12-core biopsy be done (sextant medial and lateral peripheral zone and lesion-directed). Anteriorly directed biopsy is not supported in routine biopsy. However, this can be added to an extended biopsy protocol in a repeat biopsy if PSA is persistently elevated.

Interest in the use of novel imaging, particularly MRI, to guide needle placement during biopsy (see *Imaging*, above, and *Targeted Biopsy Techniques for Repeat Biopsy*, below) has increased recently.¹⁹⁶ In addition, there is interest in saturation approaches to biopsy (often image-guided) to improve diagnostic accuracy (see *Saturation Biopsy Techniques*, below).¹⁹⁷ Another advanced prostate biopsy technique is transperineal template biopsy, which systematically samples anterior, mid, posterior, and basal zones for approximately 24 to 32 cores.¹⁹⁸

At present, the panel does not recommend routine use of advanced biopsy techniques or specific imaging other than TRUS for initial biopsy,

although they can be considered in the repeat biopsy setting as discussed below.

Targeted Biopsy Techniques for Initial Biopsy

Targeted biopsy techniques include cognitive or visual targeting (guiding with US, based on an MRI image), TRUS-MRI fusion platforms (merging a stored MRI image with a real-time US image), and direct in-bore magnetic resonance (MR)-guided biopsy (performed by an interventional radiologist while the patient is in the scanner).^{196,199,200}

Emerging data suggest that multiparametric MRI followed by lesion targeting may increase the detection of clinically significant, higher-risk (Gleason \geq 4+3) disease while lowering the detection of lower-risk (Gleason 6 or lower-volume 3+4) disease, although data in the initial biopsy setting are still limited.

In a prospective study of 223 biopsy-naïve men with elevated PSA, all men had standard TRUS biopsies in addition to multiparametric MRI.¹³² Participants with suspicious or equivocal lesions (PI-RADS \geq 3) then underwent MRI-guided biopsy. TRUS biopsies detected 126 of 142 cases of cancer (88.7%) including 47 cases classified as low risk. The MRI-guided biopsies identified an additional 16 cases of intermediate/high-risk prostate cancer and led to the reclassification of 13 cases from low risk to intermediate/high risk. Thus, the addition of multiparametric MRI with targeted biopsies for suspicious or equivocal lesions to standard biopsy allowed the identification of clinically significant disease in an additional 13% of the study population.

A single-center trial randomized 130 biopsy-naïve men to a control group that received TRUS-guided random biopsy alone or to a group that received prebiopsy multiparametric MRI, TRUS-guided random biopsy, and cognitive MRI/TRUS fusion targeted biopsy.¹³⁴ Similar rates

of detection of prostate cancer (64% vs. 57%; $P = .5$) and of clinically significant cancer (55% vs. 45%; $P = .8$) were seen in the two arms.

In another single-center study, 452 men with no prior biopsy and suspicious regions on multiparametric MRI underwent both systematic biopsy and fusion-targeted biopsy.²⁰¹ Systematic biopsies identified more cancer (49.2% vs. 43.5%; $P = .006$) but 82.9% of the 41 cancers detected by systematic biopsy and not by targeted biopsy were Gleason 6. Furthermore, targeted biopsies identified more Gleason 7+ disease (88.6% vs. 77.3%; $P = .037$). Another similar study showed similar results.²⁰²

In a large single-institution prospective cohort study, 1003 men with elevated PSA or abnormal DRE and lesions visible on multiparametric MRI underwent both MRI/US fusion-targeted and standard biopsy.¹³⁷ In this study, 196 men had no prior biopsy, and results appear to be similar in the biopsy-naïve subgroup compared with the entire cohort. Of the full cohort, 170 men had pathology results available following radical prostatectomy: 8 men (4.7%) had intermediate- or high-risk cancers that would have been missed based on targeted biopsy results of no or low-risk cancer and 44 men (26%) had intermediate- or high-risk cancers that would have been missed based on standard biopsy results of no or low-risk cancer. The sensitivities for detection of intermediate- or high-grade cancer of targeted and standard biopsies were 77% and 53%, respectively, whereas the specificities of the 2 approaches were similar at 68% and 66%, respectively. Combining both biopsy techniques increased sensitivity to 85% but decreased specificity to 49%. The effect of targeted biopsies on clinical outcomes is still unknown.

Overall, the panel believes that the data for the use of targeted biopsies in the initial biopsy setting are insufficient to recommend them over standard biopsies in this setting at this time. Until these methods are

validated in ongoing clinical trials, the panel does not recommend MRI-targeted biopsies for initial biopsy. They can be considered in the setting of repeat biopsy, as discussed below.

Repeat Biopsies

A negative biopsy does not preclude a diagnosis of prostate cancer on subsequent biopsy. If clinical suspicion of cancer persists after a negative biopsy, consideration can be given to saturation biopsy strategies and/or the use of multiparametric MRI followed by an appropriate targeted biopsy technique based on the results. In addition, biomarker testing can also be considered in these men to inform decisions regarding repeat biopsy (see *Biomarker Testing: PSA Derivatives and Other Tests*, above).

Targeted Biopsy Techniques for Repeat Biopsy

After 1 or more negative TRUS biopsies, men who are considered at high risk (eg, those with persistently elevated or rising PSA) can be considered for MRI followed by targeted biopsy based on several studies showing improved detection of clinically significant prostate cancer in this setting.^{130,203-209} Reported cancer detection rates by targeted fusion biopsies in men with previous negative biopsies range from 34% to 51%.^{130,204-206} Studies that used direct MR guidance for targeted biopsies report similar cancer detection rates in men with previous negative biopsies: 41% to 56%.²⁰⁷⁻²⁰⁹

The targeted biopsy approach may lead to a higher rate of detection of clinically significant cancer in men with prior negative biopsy, in contrast to repeat systematic biopsies, which lead to the identification of more low-risk tumors. For instance, in one retrospective cohort study, 105 men with prior negative biopsies and elevated PSA underwent multiparametric MRI followed by standard 12-core systematic biopsy and MR-US fusion targeted biopsy regardless of MRI results.²⁰⁵

Prostate cancer was found in 36 men (34%). In this study, 21 of 23 cancers (91%) identified by targeted biopsy were significant (Gleason 3 + 4 or mean core length ≥ 4 mm), compared with 15 of 28 cancers (54%) identified by standard biopsy. Targeted biopsies missed 2 cases of clinically significant cancer compared with 5 missed cases with standard biopsies.

Another prospective study included 347 patients with findings suspicious for prostate cancer, many of whom had 1 or more previous negative biopsies.¹³⁰ All patients received a multiparametric MRI, and those with abnormal findings proceeded to MRI-TRUS fusion targeted biopsies. The outcome was defined as improved detection in targeted cores, with significantly more cancer detected in targeted cores than in systematic biopsies (30% vs. 8.2%). About 12% of men without MRI-suspicious lesions were diagnosed with intermediate-risk tumors. In this study, the cancer detection rate was 51% in men with previous negative biopsies.

In a prospective study, 583 patients (56% with prior negative biopsy) underwent multiparametric MRI.²¹⁰ All men received systematic 12-core biopsies, and men with lesions seen on MRI also received fusion-guided biopsies. Multivariate analysis revealed that a higher MRI suspicious score increased the likelihood of finding Gleason 7+ cancer by 3.3-fold (95% CI, 2.2–5.1; $P < .0001$).

In another prospective study, 1003 men with elevated PSA or abnormal DRE underwent multiparametric MRI to identify suspicious regions followed by targeted TRUS-MRI fusion biopsy and concurrent standard biopsy.¹³⁷ When possible, biopsy results were compared to whole-gland pathology after prostatectomy. Whereas the 2 biopsy approaches yielded similar numbers of prostate cancer cases, the targeted approach identified 30% more high-risk cancers (173 vs. 122 cases, P

< .001) and 17% fewer low-risk cancers (213 vs. 258 cases, $P < .001$) compared with the standard approach. In the 170 men with whole-gland pathology, the predictive ability of targeted biopsy for differentiating low- from intermediate- or high-risk disease was superior to that of standard biopsy and the 2 approaches combined (AUC, 0.73 vs. 0.59 vs. 0.67, respectively; $P < .05$ for all comparisons).

A recent meta-analysis of 16 studies (1926 men) also showed that MRI-targeted biopsy improved detection of clinically significant prostate cancer in men with previous negative biopsies over standard TRUS biopsy.²¹¹ Overall, the panel believes that targeted biopsy techniques may help identify regions of cancer missed on prior biopsies and should be considered in selected cases after at least 1 negative biopsy. They can be considered before or after biomarker tests (discussed above) to aid in patient/clinician discussions.

Saturation Biopsy Techniques

In saturation biopsies, cores are collected systematically every few millimeters across the entire prostate to improve prostate cancer detection over that of a standard 12-core biopsy. Saturation biopsies can be performed via transrectal or transperineal approaches, the latter of which is often image-guided (see *Targeted Biopsy Techniques for Repeat Biopsy*, above). The approaches seem to have similar rates of cancer detection.²¹² In fact, one study compared the approaches head-to-head and found similar cancer detection rates in the repeat biopsy setting (31.4% for transrectal vs. 25.7% for transperineal; $P = .3$).²¹³ The transperineal approach may have a lower risk of infection, may allow for better saturation of the gland, and may be more acceptable to patients compared with the transrectal approach.²¹⁴ In fact, recent studies reported zero or near-zero rates of sepsis in men biopsied with the transperineal approach.²¹⁵⁻²¹⁷ Another possible benefit of the transperineal over the transrectal approach is more accurate staging.²¹⁸

However, the transperineal approach may be associated with a higher rate of urinary retention.²¹⁴ The transrectal approach can be performed in the office.

A study of transperineal template-guided mapping biopsy found detection rates of 55.5%, 41.7%, and 34.4% for men with 1, 2, and ≥ 3 previous negative biopsies, respectively.²¹⁹ Other groups have reported similar rates of detection using saturation biopsies in men with previous negative biopsies.^{217,220,221}

Compared with an extended biopsy approach (12–14 cores), one prospective, non-randomized study found that transrectal saturation biopsy detected significantly more cancers in men with 1 previous negative biopsy (32.7% vs. 24.9%; $P = .0075$).²²² The detection of insignificant cancer did not differ significantly between the groups (40.1% vs. 32.6%; $P = .2$).

Based on this emerging evidence, the panel believes that a saturation biopsy strategy can be considered for very high-risk men with previous negative biopsies.

Risks of Biopsy

The problem of repeated biopsies is gaining attention in the PSA debate, due to increasing concerns about the risks of complications, particularly drug-resistant *Escherichia coli* infections.²²³ The range of potential infectious complications includes urinary tract infection (UTI), epididymitis, orchitis, prostatitis, and sepsis. Other morbidities include rectal bleeding, hematuria, vasovagal episodes, fever, hematospermia, and dysuria.^{224,225}

In an analysis of 17,472 men in the SEER database, prostate biopsy was associated with a 2.7-fold increased risk of 30-day



hospitalization.²²⁶ These investigators also reported that while the incidence of infectious complications following prostate biopsy has increased significantly in recent years, the incidence of noninfectious complications has remained relatively stable. These results are similar to those from a Canadian study of 75,190 men who were biopsied, in which the hospitalization rate increased from 1.0% in 1996 to 4.1% in 2005.²²⁷ About 70% of all admissions were related to infections. A recent analysis of the PLCO trial, however, observed that biopsy complications were infrequent and that biopsy was not associated with a higher risk of mortality.²²⁸

Fluoroquinolones, particularly ciprofloxacin, are used commonly as a prophylaxis for TRUS biopsy. Recent studies have reported that about half of post-biopsy infections are resistant to fluoroquinolone, many of which are also resistant to other antibiotics.^{229,230} Resistance is associated with prior prophylactic exposure to fluoroquinolone.^{231,232} Although these infections will respond to cephalosporins, measures are needed to prevent additional resistant strains. One strategy is to develop more stringent criteria for biopsy. Another proposed strategy is to selectively target antibiotic prophylaxis with pre-biopsy rectal culture.²³³

Up to 90% of men undergoing a prostate biopsy have reported some discomfort during the procedure.²³⁴ Both topical lidocaine gel and an injectable nerve block have been shown to be safe and efficacious for reducing discomfort.^{235,236} Topical lidocaine was more efficacious in reducing pain during probe insertion, whereas peri-prostatic injection reduced pain during the biopsy itself. Results of one small clinical trial suggest that a combination of lidocaine suppository and periprostatic nerve block might be more effective at reducing pain during prostate biopsy than either one alone.²³⁷ Another small trial found the

combination of lidocaine with pelvic plexus block to be most effective at relieving pain associated with prostate biopsy.²³⁸

These minor anesthetic techniques greatly enhance the acceptability of the procedure, particularly with extended templates and saturation techniques, but should be considered in all patients.²³⁹ For exceptional cases such as men with anal strictures or patients who have been inadequately blocked with a periprostatic injection, intravenous sedation or general anesthesia may be advantageous.

NCCN Recommendations

General Considerations

The decision to participate in an early detection program for prostate cancer is complex for both the patient and physician. Important factors must be assessed when considering early detection of prostate cancer including patient age, life expectancy, family history, race, and previous early detection test results (see *Screening in High-Risk Populations*, above). Most importantly, the patient and physician need to understand the risks and benefits associated with the early detection and treatment of prostate cancer. Several general principles for early detection should be clearly understood before using the NCCN Guidelines:

- No portion of these early detection guidelines is designed to replace an accurate history and complete physical examination conducted by a physician.
- The general health, medical comorbidities, life expectancy, and preferences of the patient are paramount when recommending or designing an early detection program.
- Prostate cancer risk factors, such as family history and race (ie, African-American men), should be considered before decisions

are made concerning the initiation of an early detection program (see *Screening in High-Risk Populations*, above).

- Prostate cancer in its early stages has no identifiable symptoms. In advanced disease, symptoms may include urinary obstruction, prostatic bleeding, hematospermia, and bone pain. Although most men wishing to take part in early detection programs have no symptoms of prostate cancer, they may have mild to severe symptoms of lower urinary tract disease because of benign prostatic enlargement. Care should be taken to educate patients about the distinction between these two diseases when discussing the risks and benefits associated with early detection.
- A patient's history of prior testing, including DRE, PSA, PSA derivatives, and prostate biopsy, should be assessed when considering early detection.
- A thorough discussion on the pros and cons of testing must be carried out between the physician and the potential participant as outlined in the algorithm. Patients should be informed that the purpose of screening is to find aggressive cancers, that screening often detects low-risk cancers, and that such low-risk cancers may not need treatment but can be managed by active surveillance. Decision aids are available.²⁴⁰
- The panel uniformly feels that these guidelines need to be linked to the NCCN Guidelines for Prostate Cancer (available at www.NCCN.org).
- The panel recommends that baseline PSA testing should be offered to healthy, well-informed men aged 45 to 75 years based on the results of RCTs. Baseline testing may be complemented by DRE.
- The panel recommends frequency of testing be 2 to 4 years for men aged 45 to 75 years with serum PSA values below 1 ng/mL. For men with PSA of 1 to 3 ng/mL, testing should occur at 1- to 2-year intervals.
- The panel recommends that biopsy should be considered in those aged 45 to 75 years with a serum PSA >3.0 ng/mL. However, the majority of panel members agree that a decision to perform a biopsy should not be based on a PSA cut-point alone, but should incorporate other important clinical variables including age, family history, PSA kinetics, race, health status, and patient preference.
- The panel recommends that PSA testing be considered only in very select patients after the age of 75 years (category 2B) and that indication for biopsy be carefully evaluated. Panel members uniformly discourage PSA testing in men unlikely to benefit from prostate cancer diagnosis based on age and/or comorbidity.
- The panel recommends that consideration *may* be given to biomarkers that improve biopsy specificity such as %f PSA, 4Kscore, and PHI before biopsy in men with serum PSA levels of >3 ng/mL who desire more specificity. These tests and PCA3 are also options in men being considered for repeat biopsy after an initially benign result.

Discussion
update in
progress

Interpretation of Biopsy Results

Cancer

Patients diagnosed with prostate cancer by biopsy should be managed according to the NCCN Guidelines for Prostate Cancer (available at www.NCCN.org). Among men diagnosed with cancer on prostate biopsy, the panel does not recommend routine repeat biopsy, except in special circumstances, such as the suspicion that the patient harbors more aggressive cancer than was evident on the initial biopsy and the patient is otherwise a candidate for active surveillance as outlined in the treatment guidelines.

High-Grade Prostatic Intraepithelial Neoplasia

Approximately 10% of patients undergoing biopsy will be found to have high-grade prostatic intraepithelial neoplasia (HGPIN).²⁴¹ Cytologically, the nuclear features of HGPIN resemble that of malignant tumors; however, the presence of a basal layer on the acini distinguishes this entity from cancer.

Extended biopsy schemes have resulted in a dramatic decline in the prevalence of cancer detected from a repeat biopsy in patients with HGPIN detected from the initial biopsy. While reports in the sextant biopsy era demonstrated cancer rates of approximately 50%, contemporary series using extended biopsy schemes report rates of approximately 10% to 20% and occasionally higher.²⁴²⁻²⁴⁴

Interestingly, the rates of cancer with repeat biopsy in such patients seems to be a little different than those who undergo repeat biopsy based on other risk factors, such as age, family history, and PSA. In addition, most detected cancers are low grade.²⁴⁵ If extended biopsies were used initially, only those at high risk for more aggressive cancer should undergo repeat biopsy.²⁴⁶ It is recommended that those with *multifocal* HGPIN have a repeat biopsy within 6 months, with increased

sampling of the affected site and adjacent areas, as for men with atypia suspicious for cancer (see below).²⁴⁷ Men with *focal* HGPIN should be followed as men with benign results (see below).

Atypia, Suspicious For Cancer

Distinct from HGPIN in which a basal cell layer is present, atypia is characterized by small single-cell layer acini. Unlike HGPIN, which is a distinct pathologic diagnosis, atypia represents one of two possibilities: normal prostate tissue distorted by artifact or prostate cancer that does not meet the histologic criteria for a diagnosis of prostate cancer. Because so few glands are present on the biopsy specimen, an unequivocal diagnosis of cancer cannot be established.

Even in the era of extended biopsy schemes, the prevalence of cancer detected from a repeat biopsy in patients with atypia detected from the initial biopsy is quite high: 50% or more, with the most likely area of cancer detection residing in the prostate area demonstrating atypia from the initial biopsy.^{248,249}

Therefore, the panel recommends a repeat extended biopsy scheme within 6 months of an initial atypia diagnosis with additional cores obtained from the region demonstrating atypia. It is not currently known whether such patients would receive the same, or perhaps greater, benefit from the use of serum (ie, 4Kscore, PHI), tissue (ie, ConfirmMDx), or imaging (ie, multiparametric MRI) as patients with a completely negative biopsy. If no cancer is found on the repeat biopsy, close follow-up with PSA (with consideration of complementary DRE) is recommended.

Benign Results

If a biopsy returns as negative for cancer, the panel recommends repeat PSA and DRE at 6- to 24-month intervals with biopsy based on results.



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In addition, the following tests can be considered in patients thought to be at a higher risk despite a negative biopsy to inform the decision about performing a repeat biopsy: %f PSA, 4Kscore, PHI, PCA3, or ConfirmMDx. As discussed in detail above, multiparametric MRI and targeted biopsies or other refined biopsy techniques may also be considered in the evaluation of such patients.

Summary

Since the early 1990s, many variants of the tPSA assay have been introduced in attempts to increase the sensitivity of screening programs or cancer detection while maintaining specificity (elimination of unnecessary biopsies). These NCCN Guidelines recommend a method by which individuals and their physicians can use these new techniques rationally for the early detection of prostate cancer. These guidelines are not designed to provide an argument for the use of population screening programs for prostate cancer. Rather, they are meant to provide a vehicle by which early detection efforts can be practiced in an evidence-based, systematic fashion in patients who choose to participate in such programs. Whether to treat a patient upon diagnosis is beyond the scope of these guidelines (see the NCCN Guidelines for Prostate Cancer at www.NCCN.org).

These NCCN Guidelines for Prostate Cancer Early Detection incorporate many recently validated findings if and when they occur. The panel will re-examine the clinical utility of new modalities annually, and the guidelines will be modified accordingly. In addition, future iterations of these guidelines may incorporate new serum markers currently undergoing clinical investigation.

The goal of NCCN and this Guidelines Panel in updating these algorithms is to assist men and clinicians in choosing a program of early detection for prostate cancer and in making decisions regarding the

need for prostate biopsy. Any clinician who uses these guidelines is expected to exercise independent medical judgment in the context of the individual clinical circumstances to determine the patient's need for prostate biopsy. These guidelines will continue to evolve as the field of prostate cancer advances.

Discussion
update in
progress

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Discussion
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