Fluorescence spectroscopy for prostate cancer diagnosis

Clinical Policy ID: CCP.1277

Recent review date: 12/2024

Next review date: 4/2026

Policy contains: Digital rectal examination, fluorometry, fluorescence spectroscopy, prostate specific antigen, spectrofluorometry.

Coverage policy

Fluorescence spectroscopy for prostate cancer diagnosis is investigational/not clinically proven and, therefore, not medically necessary.

Limitations

No limitations were identified during the writing of this policy.

Alternative covered services

- Digital rectal examination.
- Fine needle biopsy.
- Prostate specific antigen.
- Magnetic resonance imaging targeted prostate biopsy.
- Ultrasound guided transrectal biopsy.
- Ultrasound guided transperineal biopsy.

Background

In the United States, an estimated 299,010 new cases of prostate cancer and 35,250 deaths from prostate cancer will occur in 2024. Risk of prostate cancer is higher in men aged 65 or older, in African American men, and in Caribbean men of African ancestry (American Cancer Society, 2024).

The most common means of diagnosing the disease is a Prostate Specific Antigen (blood) test, for which levels of 4.0 nanograms per milliliter or higher are considered abnormal. Digital rectal exams may also detect prostate cancer. Core needle biopsy (or sometimes an ultrasound) is used to confirm the diagnosis and evaluate the histological architecture for assessing the risk of locally advanced prostate cancer. If a biopsy is negative for cancer and there remains a strong suspicion for cancer, other testing or repeat biopsy may be required (American Cancer Society, 2023).

Systematic sampling and targeted approaches using transrectal ultrasound and multiparametric magnetic resonance imaging, performed alone or as fused images, are used to improve the diagnostic accuracy of core needle biopsy, along with transperineal approaches and robotic sampling methods. Anesthesia requirements and rates of infectious complications, bleeding, urinary retention, and erectile dysfunction are considerations with both transrectal and transperineal approaches (Gravestock, 2022).

Fluorescence spectroscopy is a non-invasive diagnostic tool that may improve cancer detection in real time using a type of electromagnetic spectroscopy to analyze biochemical tissue composition and structure. It exploits the optical properties of various tissues by applying a beam of light, typically ultraviolet, that causes electrons in molecules to emit light. The technique is also known as fluorometry or spectrofluorometry and employs two types of instruments (filter fluorometers and spectrofluorometers). It has been used for biochemical, chemical, and medical purposes and may minimize the need for repetitive biopsy (Francisco, 2014).

Findings

Guidelines

The American Urological Society's guideline on early detection for prostate cancer mentions multiparametric magnetic resonance imaging prior to initial biopsy, but not fluorescence spectroscopy, as a method for improving cancer detection (Wei, 2023). The American College of Radiology's most recent guideline on prostate cancer detection and staging does not list fluorescence spectroscopy as a means of staging prostate cancer (Akin, 2023). Finally, neither the U.S. Preventive Services Task Force guideline on prostate cancer screening nor the National Comprehensive Cancer Network guideline on prostate cancer mentions the method (National Comprehensive Cancer Network, 2024; U.S. Preventive Services Task Force, 2018).

Evidence review

No systematic reviews or meta-analyses on the topic exist. The current evidence consists of studies examining the technical feasibility of fluorescence spectroscopy in detecting cancerous prostate tissue. The evidence is insufficient to support an improvement in patient outcomes as a result of using the technology in the workup of prostate cancer.

A study of 20 surgically excised prostate glands addressed the issue of most prostate cores reported as benign. After measuring fluorescence in 187 cores, 78 samples were malignant. Sensitivity and specificity were 86% and 87%, and negative and positive predictive values were 90% and 83% (Werahera, 2014).

A review of 724 capsular and parenchymal tissue samples from 37 patients with intermediate-to-high grade prostate cancer used auto-fluorescence lifetime spectroscopy and light reflectance spectroscopy to test the accuracy of the Gleason scale score. The study resulted in agreement of 87.9%, 90.1%, and 85.1% for

parenchymal tissues, and 91.1%, 91.9%, and 94.3% when capsular tissues were included, for Gleason scores 7, 8, and 9, or high risk of the cancer spreading (Sharma, 2014).

One review used 50 prostate specimens from radical prostatectomy patients to obtain six punch biopsies from each, and four measurement points for each biopsy, making a total of 1,200 measurement points. Time-resolved fluorescence spectra resulted in a 93.4% correct classification (malignant versus non-malignant) of the 1,200 samples, suggesting a helpful diagnostic tool for both pathologists and surgeons (Gerich, 2011).

A study of concentrations of endogenous fluorophores in prostate tissue using an optical biopsy needle guided by fluorescence spectroscopy in 208 males undergoing prostatectomy surgery found 72% sensitivity and 66% specificity. The study also found a 93% negative predictive value to indicate benign tissue, leading authors to conclude that this technique can increase the diagnostic accuracy of prostate biopsies (Werahera, 2015).

In 2022, we updated the references with no policy changes warranted.

In 2023, we updated the references and guidelines, and added no newly relevant published studies to the policy. No policy changes are warranted.

In 2024, we added no newly published, relevant studies to the policy and deleted several older references. No policy changes are warranted.

References

On October 9, 2024, we searched PubMed and the databases of the Cochrane Library, the U.K. National Health Services Centre for Reviews and Dissemination, the Agency for Healthcare Research and Quality, and the Centers for Medicare & Medicaid Services. Search terms were “spectrometry, fluorescence” (MeSH), “prostatic neoplasms” (MeSH), “fluorescence spectroscopy prostate,” “fluorometry,” and “spectrofluorometry.” We included the best available evidence according to established evidence hierarchies (typically systematic reviews, meta-analyses, and full economic analyses, where available) and professional guidelines based on such evidence and clinical expertise.

Akin O, Woo S, Oto A, et al. ACR Appropriateness Criteria® pretreatment detection, surveillance, and staging of prostate cancer: 2022 update. *J Am Coll Radiol*. 2023;20(5s):S187-s210. Doi: 10.1016/j.jacr.2023.02.010.

American Cancer Society. Key statistics for prostate cancer. https://www.cancer.org/cancer/prostate-cancer/about/key-statistics.html. Last revised January 19, 2024.

American Cancer Society. Tests to diagnose and stage prostate cancer. https://www.cancer.org/cancer/types/prostate-cancer/detection-diagnosis-staging/how-diagnosed.html. Last revised November 22, 2023.

Francisco AL, Correr WR, Azevedo LH, et al. Fluorescence spectroscopy for the detection of potentially malignant disorders and squamous cell carcinoma of the oral cavity. *Photodiagnosis Photodyn Ther*. 2014;11(2):82-90. Doi: 10.1016/j.pdpdt.2014.03.009.

Gerich CD, Opitz J, Toma M, et al. Detection of cancer cells in prostate tissue with time-resolved fluorescence spectroscopy. Proc. (SPIE) 7897. Optical Interactions with Tissue and Cells XXII, 78970R. http://proceedings.spiedigitallibrary.org/proceeding.aspx?articleid=1348599. Published February 22, 2011.

Gravestock P, Shaw M, Veeratterapillay R, et al. Prostate cancer diagnosis: Biopsy approaches. In: Barber N, Ali A, editors. Urologic cancers [Internet]. Brisbane (AU): Exon Publications. Chapter 12. https://www.ncbi.nlm.nih.gov/books/NBK585968/. Published September 12, 2022.

National Comprehensive Cancer Network. NCCN clinical practice guidelines in oncology (NCCN Guidelines®). Prostate cancer. Version 4.2024. www.nccn.org. Published May 17, 2024.

Sharma V, Olweny EO, Kapur P, Cadeddu JA, Roehrborn CG, Liu H. Prostate cancer detection using combined auto-fluorescence and light reflectance spectroscopy: Ex vivo study of human prostate. *Biomed Opt Express*. 2014;5(5):1512-1529. Doi: 10.1364/BOE.5.001512.

U.S. Preventive Services Task Force. Screening for prostate cancer. U.S. Preventive Services Task Force recommendation statement. *JAMA*. 2018;319(18):1901-1913. Doi: 10.1001/jama.2018.3710.

Wei JT, Barocas D, Carlsson S, et al. Early detection of prostate cancer: AUA/SUO guideline part II: Considerations for a prostate biopsy. *J Urol*. 2023;210(1):54-63. Doi: 10.1097/JU.0000000000003492.

Werahera PN, Jasion EA, Crawford ED. Systematic diagnosis of prostate cancer using an optical biopsy needle adjunct with fluorescence spectroscopy. *Conf Proc IEEE Eng Med Biol*. 2014;2014:2165-2168. Doi: 10.1109/EMBC.2014.6944046.

Werahera PN, Jasion EA, Liu Y, et al. Human feasibility study of fluorescence spectroscopy guided optical biopsy needle for prostate cancer diagnosis. *Conf Proc IEEE Eng Med Biol Soc*. 2015;2015:7358-7361. Doi: 10.1109/EMBC.2015.7320091.

Policy updates

11/2016: initial review date and clinical policy effective date: 4/2017

11/2017: Policy references updated.

11/2018: Policy references updated.

12/2019: Policy references updated. Policy ID changed to CCP.1277.

12/2020: Policy references updated.

12/2021: Policy references updated.

12/2022: Policy references updated.

12/2023: Policy references updated.

12/2024: Policy references updated.