NIH NATIONAL CANCER INSTITUTE

Tumor Markers

What are tumor markers?

A tumor marker is anything present in or produced by cancer cells or other cells of the body in response to cancer or certain benign (noncancerous) conditions that provides information about a cancer, such as how aggressive it is, what kind of treatment it may respond to, or whether it is responding to treatment.

Tumor markers have traditionally been proteins or other substances that are made at higher amounts by cancer cells than normal cells. These can be found in the blood, urine, stool, tumors, or other tissues or bodily fluids of some patients with cancer.

Increasingly, however, genomic markers (such as tumor gene mutations, patterns of tumor gene expression, and nongenetic changes in tumor DNA) are being used as tumor markers. These markers are found both in tumors themselves and in tumor fragments shed into bod fluids.

Many different tumor markers have been characterized and are in clinical use. Some are associated with only one type of cancer, whereas others are associated with multiple cancer types.

How are tumor markers used in cancer care?

Tumor markers can provide a wide variety of information that is important for cancer care, such as

- Helping to diagnose cancer. However, having an elevated level of a tumor marker does not mean that someone has cancer. Noncancerous conditions can sometimes cause an increase in the level of a tumor marker. In addition, not everyone with a particular type of cancer will have a higher level of a tumor marker associated with that cancer. Therefore, measurements of tumor markers are usually combined with the results of other tests, such as biopsies or imaging, to diagnose cancer.
- The type of cancer

- The stage of the cancer
- An estimate of prognosis
- What treatment may be effective. Tumor markers that indicate whether someone is a candidate for a particular targeted therapy are sometimes referred to as biomarkers for cancer treatment. Biomarkers are generally measured in samples of tumor tissue. However, tumors can shed cells or bits of biological material into blood, and these can be measured by tests called liquid biopsies.
- How well the treatment is working. Periodic (or "serial") measurements of a marker made while someone is undergoing treatment can indicate whether the tumor is responding to treatment.
- Whether cancer has returned. Measuring tumor markers periodically after treatment has ended may be used to check for recurrence.

What tumor marker tests are currently being used, and for which cancer types?

A number of tumor marker tests are currently being used for a wide range of cancer types. See the list of tumor marker tests in common use for more information.

Many tumor marker tests are carried out by commercial and academic laboratories. Sometimes cancer centers use a tumor marker test developed within a single clinical laboratory (also known as a lab-developed test or LDT) to meet a specific medical need. All tumor markers, including those tested by LDTs, are tested in laboratories that meet standards set by the Clinical Laboratory Improvement Amendments program.

Can tumor markers be used to detect cancer in people who don't have symptoms?

Because tumors produce markers that can be measured in blood and other body fluids, researchers have hoped that they might also be useful in screening people for cancer—that is, detecting cancer at an early stage before it causes symptoms.

However, studies to see whether circulating tumor markers can be used to screen for cancer have generally found that these markers do not work well for screening. They often don't identify everyone with the disease (they are not sensitive enough). Or they may indicate the possible presence of cancer in people who don't actually have cancer (they are not specific enough).

Researchers are now testing whether multi-cancer detection tests (MCDs), which analyze multiple biomarkers in the blood of people without symptoms, can identify early cancers.

Most MCDs examine DNA that tumor cells release into blood. They may also analyze other biological molecules in blood, such as proteins. Tests that look at tumor markers in blood and other body fluids are sometimes called liquid biopsy tests.

Although many MCD tests are in development and several are already being marketed, much remains to be learned about how best to use these tests and their harms and benefits. A critical question is whether treating the cancers identified by MCD tests would reduce deaths from these cancers. NCI will be launching a clinical trial to better understand the implications of using MCD tests to screen for cancer.

What research is under way to develop additional tumor markers?

NCI's Early Detection Research Network (EDRN), a collaborative consortium of academic and private-sector investigators, has focused on the systematic discovery, development, and validation of biomarkers and imaging methods to detect early-stage cancers and to assess risk for developing cancer. One goal of EDRN is to develop biomarkers that can distinguish aggressive early-stage cancers from slow-growing cancers that would never cause symptoms to reduce overtreatment.

Cancer researchers are turning to proteomics (the study of protein structure, function, and patterns of expression) and proteogenomics (the integration of proteomics with genomics and gene expression analysis, or transcriptomics) with the hope of developing novel biomarkers that can be used to identify cancer in its early stages, to predict the effectiveness of treatment, and to predict the chance of cancer recurrence.

Artificial intelligence and machine learning are increasingly being investigated, including by EDRN, as tools to analyze and interpret patterns in genomic and proteomic markers that help predict cancer risk and diagnose specific cancer types.

NCI's Clinical Proteomic Tumor Analysis Consortium (CPTAC) is using a proteogenomic approach for tumor marker discovery for a growing number of cancers, including colorectal, breast, and ovarian cancers. By systematically identifying proteins (and associated biological processes) that originate from alterations in cancer genomes, CPTAC researchers have discovered new tumor subtypes, tumor microenvironment variations, and new potential proteins for targeted drug therapy. Recent innovations have suggested that these analyses could be done on a microscale using very small amounts of tumor tissue obtain from a biopsy.

The NCI Cancer Moonshot℠ Biobank is working with patient participants at community hospitals around the country to encourage them to donate tissue and blood samples over the course of their cancer treatment. The samples are sent to researchers who use them to better understand cancer and potentially identify tumor markers.

More information on NCI's role in supporting research on novel tools and methods for diagnosing cancer is available on the Cancer Diagnosis Research page.

Selected References

1. Bettegowda C, Sausen M, Leary RJ, et al. Detection of circulating tumor DNA in early- and late-stage human malignancies. *Science Translational Medicine* 2014; 6(224):224ra24. [PubMed Abstract]
2. Duffy MJ. Clinical uses of tumor markers: a critical review. *Critical Reviews in Clinical Laboratory Sciences* 2001; 38(3):225–262. [PubMed Abstract]
3. Duffy MJ. Tumor markers in clinical practice: A review focusing on common solid cancers. *Medical Principles and Practice* 2013; 22(1):4–11. [PubMed Abstract]
4. Lennon AM, Buchanan AH, Kinde I, et al. Feasibility of blood testing combined with PET-CT to screen for cancer and guide intervention. *Science* 2020; 369(6499):eabb9601. [PubMed Abstract]
5. Springer SU, Chen CH, Rodriguez Pena MDC, et al. Non-invasive detection of urothelial cancer through the analysis of driver gene mutations and aneuploidy. *Elife* 2018; 7:e32143. [PubMed Abstract]
6. Wang Y, Li L, Douville C, et al. Evaluation of liquid from the Papanicolaou test and other liquid biopsies for the detection of endometrial and ovarian cancers. *Science Translational Medicine* 2018; 10(433):eaap8793. [PubMed Abstract]

Related Resources

Biomarker Testing for Cancer Treatment

How Cancer Is Diagnosed

Prostate-Specific Antigen (PSA) Test

Tumor Marker Tests in Common Use

Targeted Therapy to Treat Cancer

Understanding Cancer Prognosis

Reviewed: December 7, 2023

Source: National Cancer Institute
Title: Tumor Markers
Link: https://www.cancer.gov/about-cancer/diagnosis-staging/diagnosis/tumor-markers-fact-sheet