Study Of Panseer Test To Turn Down Cancer Mortality Using ML Algorithm

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ABSTRACT

Cancer can be life threatening if the tumors affect the function of the major organs. Malnutrition, a weakened immune system, and lack of oxygen support cancerous cells to grow vigorously. Cancer treatments can prevent some of these complications, as well as disease progression to its next stage.Chinese scientists discovered a new blood test that can detect five kinds of cancer up to four years before a doctor could. As we are aware of how rapidly cancerous cells divide and redivide giving rise to tumor, tests like PanSeer can reduce the cancer mortality. It is possible to detect cancer 4 years in advance, increasing the chances of survival and resisting its next stage. PanSeer is a technology which uses machine learning algorithms to detect cancer from blood samples. PanSeer is a novel blood test that has been developed to detect early-stage cancer by identifying small fragments of tumor DNA that circulate in the bloodstreamThe test effectively detects five types of cancer with high accuracy: stomach, esophageal, colorectal, lung, and liver cancer. PanSeer is an early detection test which puts together existing technologies for many different genome tests.

KEYWORDS: Cancer, PanSeer, Tumors, ctDNA, PCR, DNA Marker.

I. INTRODUCTION

Cancer can be a life-threatening disease if it is not detected and treated early. This is because cancer cells grow vigorously and spread to other parts of the bodyentering its next stage, leading to the development of tumors and the destruction of healthy tissues. When cancer is identified early, it becomes easy to treat and increase the chances of survival. However, when cancer is detected lateand if it has reached an advanced stage, it becomes more difficult to treat and may have spread to other parts of the body, more the medications more is the suffering. Late-stage cancer can accelerate a range of symptoms and complications, including pain, fatigue, trauma, weight loss, and organ failure. In some cases, the cancer may be so advanced that treatment options are limited, andgoal of

care may shift to remedial care to manage symptoms and improve quality of life. Hence, it is important to undergo regular cancer screening test and to start taking preventive measures by consulting oncologist if you experience any symptoms that could be indicative of cancer. Early detection and treatment can increase the chances of survival and turn down the cancer mortality.

PanSeer is a diagnostic blood test advanced by a group of researchers at the Stanford University School of Medicine.Its motive is to detect cancer in its early stages, 4 years in advance. PanSeer is a blood test that has been advanced to find out early-stage cancer by recognizing small fragmentsof circulating tumor DNA which circulates in the bloodstream. The test is particularly effective in detecting cancers that are difficult to diagnose through conventional screening methods, such as pancreatic, liver, esophageal and colorectal cancers.

The PanSeer test recognizes methylation patterns analogous with cancer cells, allowing the detection of tumors at a very early stage, it proves more effective when cancer is identified at its stage one.

II. LITERATURE SURVEY

During survey of PanSeer test, the research question like "What is the effectiveness of the PanSeer test in detecting early-stage cancer?" gave a clear idea that how effective it could be if this test is implemented on an individual. We used databases such as journal Nature communication, Google scholar and PubMed.

Researchers used PanSeerfor analyzing blood samples from more than 120,000 populationof China over a span of several years, stated in a study published in the journal Nature Communications in 2020. They found that the test was able to detect cancer in people who had not yet developed any symptoms, and in some cases, up to four years before the cancer was diagnosed through conventional methods.[4]

The study reported that the PanSeer test detected cancer with a sensitivity of 86% and a specificity of 99% in the cohort. Sensitivity refers to the proportion of true positives (people with cancer who test positive), while specificity refers to the proportion of true negatives (people without cancer who test negative). A sensitivity of 86% means that the test correctly identified 86% of people with cancer, while a specificity of 99% means that the test correctly identified 99% of people without cancer.[2]

However, it's important to note that this study was conducted on a relatively small unit of individuals, and further deep research is needed to validate the test's performance in larger and more diverse patient populations, till then can't be used on large scale.

The test has not yet been approved on alarge-scale clinical use and is still in the early stages of advancement.

The results of this study suggest that it has the potential to revolutionize cancer screening and diagnosis, particularly for cancers that are difficult to detect in their early stages.

III.   COMPARATIVE ANALYSIS

At present, there is no single test that can reliably detect all types of cancer in advance, before cancerous cells are present. However, there are several techniques used to detect cancer early, which can greatly improve the chances of successful treatment.

One technique used to detect cancer early is cancer screening. This involves using a test to look for signs of cancer in people who do not have any symptoms. Examples of cancer screening tests include mammograms to screen for breast cancer, colonoscopies to screen for colon cancer, and Pap smears to screen for cervical cancer.

In addition to cancer screening, there are also several blood tests that can help detect cancer early. These tests look for specific substances, such as proteins or genetic mutations, that are often associated with cancer. Some examples of blood tests used to detect cancer include:

- Cancer antigen 125 (CA-125) test: This test measures the level of a protein called CA-125 in the blood, which is often elevated in women with ovarian cancer.

- Prostate-specific antigen (PSA) test: This test measures the level of PSA in the blood, which can be elevated in men with prostate cancer.

- Liquid biopsy: This test looks for small pieces of DNA or other genetic material that are shed by cancer cells into the blood. Liquid biopsies can be used to detect several types of cancer, including lung cancer and colorectal cancer.

It is important to note that while these blood tests can be helpful in detecting cancer early, they are not foolproof and can sometimes give false-positive or false-negative results.

PanSeer is a recently developed blood test that is designed to detect early-stage cancer by identifying tiny traces of tumor DNA in the bloodstream. This test has shown promising results in detecting several types of cancer, including pancreatic, liver, ovarian, esophageal, colorectal, lung, and breast cancer.

Compared to traditional cancer screening tests like mammograms, colonoscopies, and PSA tests, PanSeer has several potential advantages. Here are a few:

- PanSeer is minimally invasive: Unlike traditional screening tests that require invasive procedures like biopsies or colonoscopies, PanSeer only requires a simple blood draw, making it less uncomfortable and less risky for patients.
- PanSeer may detect cancer earlier: Because PanSeer is designed to detect tiny traces of tumor DNA, it may be able to detect cancer at earlier stages than traditional screening tests. Early detection can improve the chances of successful treatment and improve patient outcomes.
- PanSeer may be more accurate: Early studies suggest that PanSeer may be more accurate than traditional screening tests in detecting cancer. For example, a study published in the journal Nature Communications found that PanSeer was able to detect pancreatic cancer with a sensitivity of 70%, compared to just 7% for the current standard screening test.
- PanSeer may be more cost-effective: While the cost of PanSeer is not yet known, it is possible that it may be more cost-effective than traditional screening tests. Because PanSeer only requires a simple blood draw, it may be less expensive than invasive procedures like biopsies or colonoscopies.

It's important to note that while PanSeer shows promise as a new tool for detecting cancer, it is still in the early stages of development and more research is needed to determine its efficacy and potential limitations. Additionally, it's important to remember that no screening test is 100% accurate, and all screening tests have the potential for false positives or false negatives.

IV. TYPES OF CANCER PanSeer CAN DETECT ARE:

The test has been shown to detect five types of cancer with high accuracy: stomach, esophageal, colorectal, lung, and liver cancer. Here is a detailed explanation of each of these cancers, including how they spread and their potential impact if not detected and treated early:

Stomach cancer:
Stomach cancer, also known as gastric cancer, starts in the cells that line the stomach. It is often diagnosed at a late stage because early symptoms are mild and easily ignored. Stomach cancer can spread to other parts of the body, such as the liver, lungs, and bones. If not detected and treated early, it can cause death. Symptoms of stomach cancer include abdominal pain, bloating, loss of appetite, nausea, and vomiting.

Esophageal cancer:
Esophageal cancer starts in the cells that line the esophagus, the muscular tube that connects the throat to the stomach. It is often diagnosed at a late stage because early symptoms are mild and easily ignored. Esophageal cancer can spread to other parts of the body, such as the liver, lungs, and bones. If not detected and treated early, it can cause death. Symptoms of esophageal cancer include difficulty swallowing, chest pain, weight loss, and heartburn.

Colorectal cancer:

Colorectal cancer starts in the cells that line the colon or rectum. It is often diagnosed at a late stage because early symptoms are mild and easily ignored. Colorectal cancer can spread to other parts of the body, such as the liver, lungs, and bones. If not detected and treated early, it can cause death. Symptoms of colorectal cancer include abdominal pain, bloating, changes in bowel habits, and blood in the stool.

Lung cancer:

Lung cancer initializes in the cells that line the air passages in the lungs. Generally, it is diagnosed at a late stage because early symptoms are mild and easily ignored. Lung cancer is malignant, can spread to other parts of the body, such as the liver, brain, and bones. If not identified and treated early, it can cause death. Symptoms of lung cancer include persistent coughing, shortness of breath, chest pain, and coughing up blood.

Liver cancer:

Liver cancer initializes in the cells of the liver. Generally, it is diagnosed at a late stage because early symptoms are mild and easily ignored. Liver cancer can spread to other parts of the body, such as the lungs and bones. If not identified and treated early, it can cause death. Symptoms of liver cancer include abdominal pain, bloating, fatigue, and loss of appetite.

In summary, allofthese cancers can be deadly if not detected and treated early. Symptoms are often mild and easily ignored, which is why early detection is so important. PanSeer is a promising new tool that can help detect these cancers at an early stage, increasing the chances of successful treatment and long-term survival.

V.   METHODOLOGY

According to the research published on PanSeer, the test detects cancer by analyzing the levels of circulating tumor DNA (ctDNA) and specific proteins in the blood. The proteins that are analyzed are not yet fully known, but in the published research, the scientists analyzed a panel of 16 proteins that are known to be associated with cancer.

The panel of proteins analyzed by PanSeer includes proteins involved in DNA damage and repair, cell growth and differentiation, and inflammation. The levels of these proteins in the blood are compared to a reference range to determine if they are elevated, which could indicate the presence of cancer.

PanSeer is an algorithm developed to detect early-stage cancer from blood samples. The algorithm uses a machine learning approach to analyze DNA methylation patterns in the blood to identify cancer-related signals.[2]

Here are the steps involved in the PanSeer algorithm:

1. **Data Collection**: The PanSeer algorithm uses blood samples collected from individuals who have been diagnosed with cancer or are cancer-free.
2. **DNA Extraction**: The DNA is extracted from the blood samples, and DNA methylation data is generated using bisulfite sequencing.
3. **Data Preprocessing**: The methylation data is preprocessed to remove low-quality probes and normalize the data to account for batch effects.
4. **Feature Selection**: The PanSeer algorithm selects the most informative methylation probes using a feature selection approach. This reduces the number of features to a manageable level and removes noise from the data.
5. **Model Training**: The selected methylation probes are used to train a machine learning model, such as a support vector machine or a random forest classifier, to predict cancer status. The model is trained using labeled data, where the cancer status of the individuals in the training set is known.
6. **Model Validation**: The trained model is then validated on a separate set of data, which was not used during the training phase. This is done to ensure that the model generalizes well to new data and is not overfitting the training data.
7. **Prediction**: Finally, the trained model is used to predict the cancer status of new blood samples. The methylation data from the new samples is preprocessed and the selected features are extracted. These features are then fed into the trained machine learning model, which outputs a predicted cancer status.

Overall, the PanSeer algorithm involves collecting blood samples, extracting DNA, preprocessing, and selecting informative features, training a machine learning model, validating the model, and using the model to predict cancer status from new samples.

VI. WORKING PRINCIPLE

PanSeer works by analyzing the methylation patterns of circulating tumor DNA in the blood. Methylation is a process by which a methyl group is added to DNA, which can affect the way that genes are expressed. Cancer cells have distinct methylation patterns, which can be identified through DNA sequencing. The test works by analyzing the blood of individuals who have no symptoms of cancer to identify the presence of tiny fragments of DNA that are shed by tumors into the blood, called circulating tumor DNA (ctDNA). PanSeer uses a technique called "ultra-sensitive methylation profiling" to detect the presence of ctDNA in the blood. Methylation is a chemical modification that occurs on the DNA molecule and can be used as a biomarker for cancer.

Blood samples were collected from 123,115 individuals from 2007 to 2014 and separated into plasma as part of the Taizhou Longitudinal Study.[6]

Category	Sum of Total	Sensitivity (%, 95% CI)	Specificity (%, 95% CI)	Sum of Training of Samples
0–1 year before diagnosis		100 (84.6–100)		22
1–2 year before diagnosis		90.5 (69.6–98.8)		21
2–3 year before diagnosis		94.7 (74.0–99.9)		19
3–4 year before diagnosis		83.9 (66.3–94.6)		31
Healthy	414		94.7 (90.7–97.3)	207
Post-diagnosis	223	88.2 (80.6–93.6)		110
Pre-diagnosis	191	91.4 (83.8–96.2)		93
Total	828			503

From: Non-invasive early detection of cancer four years before conventional diagnosis using a blood test

Below pie chart shows the data of test undertaken in Taizhou, China.
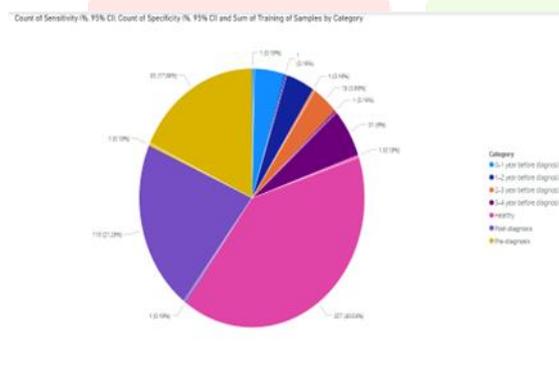
Pie chart: Visualized in PowerBI Desktop.
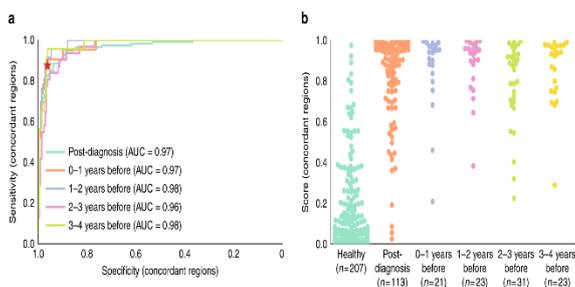
From: Non-invasive early detection of cancer four years before conventional diagnosis using a blood test

The above data shows the results of PanSeer test performed on individuals in Taizhou, which sits in the center of China.

VII. TECHNOLOGYUSEDIN PANSEER TEST

The system uses machine learning algorithms to detect early signs of cancer in blood samples.

According to the research paper published in Nature Communications in July 2020, the PanSeer system uses a combination of several machine learning algorithms, including a logistic regression algorithm, a random forest algorithm, and a support vector machine (SVM) algorithm. These algorithms are used to analyze the data from blood samples and identify the presence of cancer in the early stages.

The logistic regression algorithm is used to model the relationship between the dependent variable (presence of cancer) and the independent variables (biomarkers measured in blood samples). The random forest algorithm is used to generate a set of decision trees and to classify the data based on the most important features. The SVM algorithm is used to separate the data into different classes and to identify the most relevant biomarkers for cancer detection.

Overall, the PanSeer system combines multiple machine learning algorithms to achieve high accuracy in detecting early signs of cancer in blood samples.

Specifically, PanSeer uses a technique called "methylation profiling" to analyze DNA methylation patterns in the blood. Methylation is a chemical modification of DNA that can affect gene expression and is often altered in cancer cells. [2]

PanSeer analyzes these methylation patterns using machine learning algorithms to identify whether someone is at risk of developing cancer.

In summary, the technology used in PanSeer includes:

1. **Methylation profiling**: A technique used to analyze DNA methylation patterns in the blood.
2. **Machine learning algorithms**: Used to analyze the methylation patterns and identify those at risk of developing cancer.

VIII. FUTURE SCOPE

PanSeer is a promising tool that uses machine-learning algorithms to detect early-stage cancers through blood tests. It is an exciting area of research that could have a significant impact on cancer diagnosis and treatment. If research is taken in an effective manner, the future scope of PanSeer could be substantial.

Some potential future directions for PanSeer research include:

1. **Improving accuracy**: Researchers could work on increasing the accuracy of PanSeer by identifying additional biomarkers and developing more sophisticated algorithms.
2. **Clinical trials**: Conducting large-scale clinical trials to validate the effectiveness of PanSeer in detecting early-stage cancers could be a critical next step.
3. **Developing new applications**: The technology behind PanSeer could potentially be applied to other diseases beyond cancer, such as infectious diseases or autoimmune disorders.
4. **Personalized medicine**: PanSeer could be used to develop personalized treatment plans for cancer patients by identifying the specific genetic mutations driving their cancer.
5. **Developing non-invasive diagnostics**: The development of non-invasive diagnostics could help to reduce the discomfort and invasiveness associated with traditional cancer screening methods.

IX. CONCLUSION

PanSeer is a promising approach for the early detection of cancer using a blood test. The results of the study suggest that the PanSeer test can detect cancer up to four years before conventional clinical diagnosis methods. The study used a large sample size and was conducted over several years, which strengthens the validity of the findings.

However, it is important to note that the PanSeer test is still in the early stages of development and has not yet

been approved by regulatory agencies for widespread use. Further studies and validation are necessary to determine the accuracy, specificity, and sensitivity of this test. Additionally, even if the test is accurate in detecting cancer, it does not necessarily mean that it can be used as a standalone diagnostic tool and may need to be used in combination with other tests and diagnostic tools.

In summary, the PanSeer test has shown promising results in detecting certain types of cancer in early stages, but further research is necessary before it can be used as a standard diagnostic tool.

X.   ACKNOWLEDGEMENT

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