Lung Cancer- Treating and Diagnosing The Deadly Disease

November 6, 2015 · Health Sciences

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Jones A. Lung Cancer- Treating and Diagnosing The Deadly Disease. Young Scientists Journal. 2015 Nov 6 [last modified: 2016 Jan 31]. Edition 1.

Abstract

In this article, I will explore the complexity of lung cancer and why it is classed as one of the most deadly cancers. As well as this, I will explain how different types of lung cancer are classified depending on the cells present in tumours and how the classification affects the treatment a patient is given. Furthermore, I will look at the current treatments for lung cancer and how they are used. And last but not least, I will explain what Circulating Tumor Cells (CTCs) are and how they may be able to help scientists diagnose and treat lung cancer in the near future.

Introduction

Treatment of lung cancer has shockingly low success rates. The disease mainly affects people between the ages of sixty and eighty years old. Young people can develop lung cancer, however, it is a rarity.[1] 30% of people with lung cancer only survive 1 year after diagnosis, 10% survive 5 years or more and only 5% survive 10 years or more after diagnosis. The success rates depend on the stage of lung cancer at diagnosis. Unfortunately, most people are diagnosed in the late stages of their lung cancer. [2] But why is this the case? Why is it so challenging to spot signs of lung cancer in the early stages? In this article, I will explain why it is so difficult to diagnose lung cancer early on and how new advances in treatments using Circulating Tumour Cells could potentially increase the survival rates of lung cancer sufferers.

The 'lowdown' on lung cancer

In a cigarette, tar is the component that contains a range of substances known as carcinogens. Carcinogens cause mutations in the DNA of cells leading to cancer. This then causes uncontrollable cell growth and eventually forms what is called a malignant tumor (cancerous tumors). They can grow rapidly and block the flow of air in and out of the lungs. This decreases the rate of gas exchange causing wheezing due to shortness of breath. Malignant tumors are also known to absorb the nutrients from the body which can lead to the person having severe weight loss and lack of energy.[3]

Types of lung cancer

Non-small cell lung cancer (NSCLC) makes up **87%** of lung cancer cases so is the most common. This type grows and spreads more slowly[4] , there are three main subtypes:

1. Squamous cell carcinoma – This cancer is mostly caused by smoking and occurs in the epithelium of the bronchi. It forms masses which hollow out and bleed. This is known as cavitation[5]

2. Adenocarcinoma – A form of lung cancer found in the peripheral areas of the lungs and develops from bronchial and alveolar cells. [5]

3. Large Cell Carcinoma– The cells present in this type of lung cancer have distinctly large and round structures under a microscope and grow rapidly. [4]

Another type of lung is known as **small cell lung cancer(SCLC)**. **12%** of patients are diagnosed with this form of lung cancer and it is usually caused by smoking. Under a microscope, it is very clear a person has SCLC because the cells present in the malignant tumor have a nucleus and give the cells a blue appearance. [6] This type of lung cancer spreads early on and so doctors often recommend chemotherapy to their patients instead of surgery. [4]

Around 1% of lung cancer cases are unknown types which cannot be classified when tissue taken from a patient is biopsied.[4] Often when a tissue biopsy is taken, it isn't very helpful to researchers who are trying to discover these unknown types as Professor Caroline Dive explains:

'Often when a biopsy is produced, it's quite small. By the time it's gone to the pathology team for a diagnosis, there's not

The difficulties faced with detection and diagnosis

Whilst scientists are trying to have a better understanding of lung cancer, it is remains one of the most deadly cancers for many reasons, including the fact that diagnosis is extremely difficult. The main symptoms to look out for are:

1. Persistent coughing
2. Chest pain
3. Shortness of breath
4. Unexpected weight loss
5. Hoarseness
6. Bronchitis [7]

However on their own, these symptoms are seen as harmless and non–specific, and this is where the problem arises. Another reason why diagnosis is so complex is because the symptoms generally do not worsen or become more prominent until the person has reached the more advanced stages of their cancer. Consequently, this leads to a late diagnosis in Stage 3 or Stage 4 of the disease, with less treatment options and a decrease in survival rate.[7]

Current treatment for lung cancer

The table shows the different methods of treatment used for different types of lung cancer, as well as side effects, complications, treatment and recovery time.

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Fig. 1: Lung Cancer Treatment Table

Lung Cancer Treatment Table

This table allows us to see the overall usefulness of each type of treatment by looking at the advantages and disadvantages of each. It gives us a basic insight into what a doctor has to look at when considering the type of treatment which is suitable for their patient. However, it is necessary to emphasise that this is a basic way of showing how doctors do this and so it is likely that deciding the right treatment becomes a lot more complicated than this. For example, doctors need to consider the stage of cancer the person has, their age, health, lifestyle and many other factors. What if the type of cancer a patient has is currently an unknown type? To try and tackle this, scientists are beginning to analyse blood samples from individual patients as they feel this could provide them with vital clues on how to best treat the disease and provide patients with a form of personalised therapy. This could lead to doctors finding the right treatment for a patient quickly and efficiently with a higher chance of the treatment being a success. Moreover, analysing a type of cell in the blood could lead to more lung cancer cases being diagnosed in the early stages.

Circulating Tumor Cells (CTCs)

CTCs are cells which have shed from primary tumours into the vascular system and then circulate in the bloodstream. They are known to cause metastasis [8] which is the spread of cancer to other body parts. This causes the cancer to no longer be local, and becomes very difficult to treat. However, from current research, it has been found that CTCs also hold vital information as to how individuals can receive the best treatment for their type of lung cancer.[9] This means that the treatments can be specifically catered to each patient – and the treatment method can be found out just by doing a simple blood test also known as a liquid biopsy (which is a lot more patient friendly). Scientists count the number of CTCs present in a patient's blood as this can allow them to track how a patient is responding to their treatment.[10]

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Fig. 2: CTC's

CTC's

Tracking down CTCs

The majority of us at least once in our lives have attempted to win a toy from a Claw Machine in an arcade – with very little success. This is very similar to trying to track and capture CTCs in a blood sample. In a blood sample there can be as many as 60 million white blood cells – but just 5 CTCs;[10] almost like trying to find a needle in a haystack. However, scientists are experimenting with different ways to efficiently capture these CTCS.

Acoustic Isolation using a Chladni Plate

A Chladni Plate can be used to arrange particles in characteristic nodal patterns[11] that respond to changes in sound and frequency. The Chladni plate was created by Ernst Chladni in the 19th century and it wasn't until recently that scientists began to experiment with different sounds and frequencies to isolate diseased cells such as CTC's. The nodal patterns are created by vibrations which take the form of Sound Acoustic Waves (SAW).[12] The different frequencies applied cause the different living cells to separate due to their mechanical properties. This will allow scientists to identify and isolate CTC's easily so that they can quickly diagnose and choose the right treatment for the patient's lung cancer.

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Fig. 3: Chladni Plate

Chladni Plate

Nano-tastic Diagnosis

Professor Yaling Liu is in the process of creating a diagnostic device which can tell doctors what stage of cancer a patient has or if there are any cancerous cells present in the patient's blood sample. CTCs have a rough surface due to the presence of microvilli on their outer surface. The nano chip has a unique capture path that has been designed to be complementary to the outer surface of the CTCs. This means that the device can capture all the CTCs present in the patient's blood sample when it is injected into the chip. The nano chip is also made from an extremely cost efficient polymer, polydimethylsiloxane (PDMS), which means that this diagnostic tool could one day be used to find the right treatment for cancer patients.[13]

Summary

This article has shown just how dangerous lung cancer is due to difficulties with diagnosis and current treatment options. We still do not know what exactly causes some people to get lung cancer and others not to. Some people have never smoked their whole lives or have been exposed to radiation; however they are still diagnosed with lung cancer. Fortunately, help is on its way. At this very moment, scientists around the world are working towards creating devices, such as the ones aforementioned, to increase the number of lung cancer survivors. Analysing CTCs from a fluid biopsy will not only potentially lead to early diagnosis, but it can help researchers around the world to understand clearly the biology of lung cancer and the specific reason a patient has the disease. Hopefully in the future, lung cancer won't be such a devastating and deadly disease.

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