

# Lung Cancer Epidemiology

## How does Lung Cancer affect processes in the body?

LC is a type of uncontrollable rapid cell divisions (tumours) starting in the upper airway and gradually spreading into the rest of the lungs. These tumours restrict airways and inflame the lung epithelial lining, causing decreased gas exchange. As a result, cells are unable to aerobically respire, and the body cannot effectively rid itself of carbon dioxide.

## What is the severity of the disease?

Out of 10,000,000 global deaths caused by cancer, LC as the leading cause, accounts for 1/5 of them (killing more people yearly than colon, breast and prostate cancers combined). It is the leading cause of cancer-related deaths in the EU (267,700 deaths in 2012 representing approx. 20% of all cancer deaths). There is an 80-90% survival rate when diagnosed at stage 0-1. As a result, early diagnosis is pivotal in increasing global lung cancer survival rate.

## What are the links between modern issues and the disease severity?

LC in low/middle-income countries is the leading cause of cancer deaths in males and females respectively. Worldwide, approx. 70% of cancer deaths occur in LMICs: LC makes up a large amount. Smoking is the leading risk factor for LC and over 80% of smokers worldwide live in LMICs. Another risk factor is poor air quality and pollution is another global issue.

# Our proposal

## What's the big idea?

AirAware is a disposable LC diagnosis solution largely targeted towards LIDC. Utilising Sialic Acid biomarkers held in nanoparticle drug-loading cargos, binding to the EGFR (cell division promoting) protein, an antigen produced in far higher quantities in earlier stages of cancer. Upon the binding of Sialic Acid to biomarkers a positive result through is triggered through an LED, if enough of the sites inhaled in the body are marked as 'full'. Packaged in biodegradable paper pulp boxes, the testing kits come sanitised and sealed in biodegradable Nature Flex film.

## Implementation of Technology in the Future

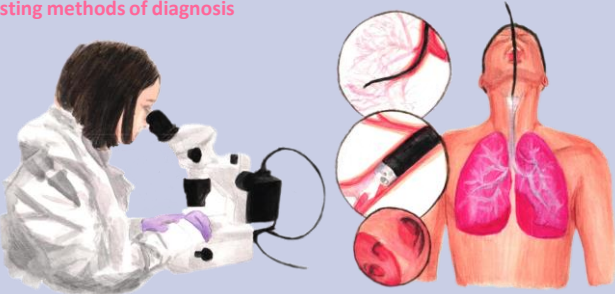
Utilising radioactive biomarkers with a tracer on the AirAware unit will allow determination of the location of lung cancer sites alongside their presence, allowing for direct treatment in affected areas increasing chance of survival

## How is AirAware used?

1. The patient presses the button at the top of the test kit and inhales at the same time
2. The patient should wait and in less than a few minutes the LED should display either a green, yellow or red colour
3. Red colour indicating a negative result, and yellow indicating an invalid result and green indicating a positive result

# Pre-existing Lung Cancer diagnosis methods

## Existing methods of diagnosis



### Sputum Cytology

Sample of sputum (mucus coughed up from the lungs) is analysed to check for the cancer cell presence

- ✓ Less Invasive
- ✓ Inexpensive

- ✗ Cytologic samples require additional testing to validate, increasing diagnosis time
- ✗ Unreliable for screening

### Bronchoscopy

A flexible tube with a light an eye piece called a bronchoscope is inserted down the trachea into the airways, it visually identifies tumours

- ✓ Tissue Biopsy
- ✓ Tumour identification
- ✓ Airway stent placements

- ✗ Extremely invasive
- ✗ Bleeding
- ✗ Choking
- ✗ Hoarseness
- ✗ Infection

### Thoracentesis

If pleural diffusion has occurred (fluid collects around the lungs). Doctors can remove this fluid to check for cancer cells

- ✓ Fast diagnosis time
- ✓ Relieves lung pressure

- ✗ Invasive
- ✗ Risk of air accumulating pushing on lung collapsing it
- ✗ Infection



# AirAware

A biomarker inhaler used to diagnose lung cancer (LC) through electro-antigenic biomarker detect.

Through instantaneous mass detection our product offers a simple, accessible and sustainable solution for LC diagnosis, designed with people and the planet in mind.

## Antigen and Biomarker Study

What is the significance of antigens and biomarkers in Lung Cancer diagnosis?

Pathogen-specific antigens are used as diagnostic markers to detect the infection status of an individual, as they often are newly-produced or in far higher quantities as a result of the infections presence.

To identify a suitable antigen and biomarker for use in AirAware they must fulfil a set of given parameters

1. Production of the biomarker must not be influenced by (environmental) factors other than progression of Lung Cancer
2. Molecule and Biomarker must engage in chemical reaction

## Cancerous Lung Tumour

## AirAware Practicality and Feasibility

### How will it be distributed and how much does it cost?

AirAware test kits distributed in UK through community centres and local GP's and hospitals, promoted during patient consultation. To be funded in by the NHS long plan

In low-income developing countries the test kit's can be distributed at community centres and local hospitals. To be funded by UNITAID under WHO and SD Biosensor, Clinton Health Access Initiative in these countries.

An 100/mcg inhaler is manufactured at a price: £1.97/unit, with similar sizing and accounting for circuitry and nanoparticle manufacturing £4/unit, with 2.2 million average lung cancer cases per year, over 8 million tests should be produced, this values the AirAware initiative at approximately £32,000,000

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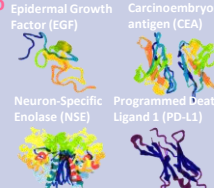


Our references:

## Understanding the Cancer Protein Pathway

### Biomarker and binding molecule identification according to lung cancer pathogenesis

Commonly identified biomarkers associated with LC were identified alongside relevant molecules that could be used, however they each had problems deeming them unsuitable; production in immune systems or production increased by factors other than LC progression. EGF - A transmembrane protein responsible for regulating the signalling pathways which control cell division. A mutation of the EGFR gene can result in the overproduction of the antigen leading to increased cell division - cancer. Sialic Acid is a molecule able to undergo sialylation, forming bonds with glycoproteins or glycolipids, as EGFR codes for a glycoprotein it can form bonds with the acid, making it a suitable binding molecule, tying in perfectly with our cancer diagnosis method.



## Electro-antigenic biomarker detection: Sialylation

### How does our chosen antigen interact with our biomarkers in AirAware?

Sialic acid biomarkers inhaled using AirAware and travel towards cancer site in bioactivated microfluidic carbon nanotube vehicles. Sialic acid, when introduced to cells nearing division producing Growth Factor Cytokine hormones, will bind to them. As EGFR is needed for cell division hundreds of nanotube vehicle sites will be used to determine a result. Over half the sites must produce a positive result otherwise it can be determined EGFR activity is regular, if exactly half the sites are full the test produces a void result

Interaction between EGF and Sialic Acid molecules causes sialylation to occur. Polar covalent bond formed between molecules with unequal electron distribution at binding site. The capacitance of binding site changes, impedance of binding site changes. Electrons from binding site repel electrons at cathode towards the anode introducing a charge to the circuit in the direction of the conventional current. Alternating  $V_{in}$  on charge causes high frequency change in input signal. Resistance in  $R_i$  decreases. Charge is amplified through operational amplifier. Signal changes from 0 to 1.

## AirAware Unit Design

### What features does the test kit have?

Using Fusion 360 multiple AirAware designs were tweaked until the final design as seen in the renders was produced. Optimising product design was a priority in order to solve the existing problems with pre-existing diagnosis methods.

- Diagnosis Time - AirAware provides a diagnosis in under 2 minutes
- Invasiveness - Inhalation required as opposed to invasive surgeries
- Price - Free global kits to prevent lung cancer cases worldwide
- Ergonomics - Ovalar mouthpiece and indented side body
- Usage - Portable and accessible test kit
- Sustainability - Designed with recyclable HDPE and packaged with NatureFlex, a biodegradable plastic polymer



## Sialic Acid Trialling

### How will the drugs used be safely tested?

