WHITEPAPER

Applying artificial intelligence for early detection of lung cancer

Clinical decision support tools from Arkangel AI

Arkangel Ai

About Arkangel AI:

Arkangel AI is a software company based in Montreal, Canada that specializes in early disease detection using artificial intelligence. The company's mission is to enable people to live free of preventable diseases through early disease detection. Arkangel AI's products are optimized for diseases from the global south and medical equipment available in the region, translating into fewer entry barriers to urban and rural settings. Arkangel AI has operations in Canada, Colombia, Uruguay, and Mexico. For further information on this research or strategic partnerships:

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Introduction

According to the WHO, cancer is a term used to describe a broad group of diseases capable of affecting any body part. Its main characteristic is the rapid multiplication of abnormal cells that extend beyond its limits and sometimes manage to invade other organs or parts of the body [1]. Lung cancer is a type of cancer that forms in the tissues of the lung, most often in the cells that line the airways. Although this cancer begins in the lungs, it can also spread to the lymph nodes or other organs in the body. In the same way, different cancer originating in other organs can reach the lungs, known as metastasis [2].

Tumors of this type of cancer are divided into two histological categories. The first is non-small cell lung carcinoma (NSCLC), which accounts for more than 80 to 85% of lung cancers. Of these, approximately 40% are adenocarcinomas, 25% to 30% are squamous cell carcinomas, and 10% to 15% are large cell carcinomas [3]. The second is small cell lung carcinoma (SCLC), which is aggressive and often caused by smoking, comprising 15 to 20% of all primary lung cancers [4]. There is another type called bronchioloalveolar carcinoma (BAC). This is a different histological classification that has been replaced by minimally invasive adenocarcinoma and invasive lung adenocarcinomas [5].

The risk factors associated with lung cancer are described in the following table, along with the magnitude of association they represent:

Risk factor	Magnitude of association
Smoke tobacco	20 times higher risk compared to never smoker
Smoke	25% to 28% higher risk vs. never smoker
Electronic cigarettes	Currently unknown
Smoked cannabis	Now there is no known risk
History of COPD, emphysema, or chronic bronchitis	2 to 3 times higher risk
History of asthma	28% to 44% higher risk
History of pneumonia	30% to 57% higher risk
History of tuberculosis	48% to 76% higher risk
HIV	Two times higher risk

Table 1. Established and putative risk factors for lung cancer [6].

Lung cancer is the most diagnosed type of cancer in recent decades worldwide. For the year 2018, approximately 2.1 million people were diagnosed with lung cancer; this represents 12% of the global burden of cancer [7][8]. The incidence of this type of cancer in women is lower than in men; generally, this is represented in geographical variations where historical differences in cigarette consumption are attributed. In men, the incidence is highest in Micronesia, Polynesia, Central/Eastern Europe, and East Asia and low in Africa (see Figure 1) [8]. In women, the incidence is highest in North America, Northern Europe, Western Europe, and Australia (see Figure 1) [8].

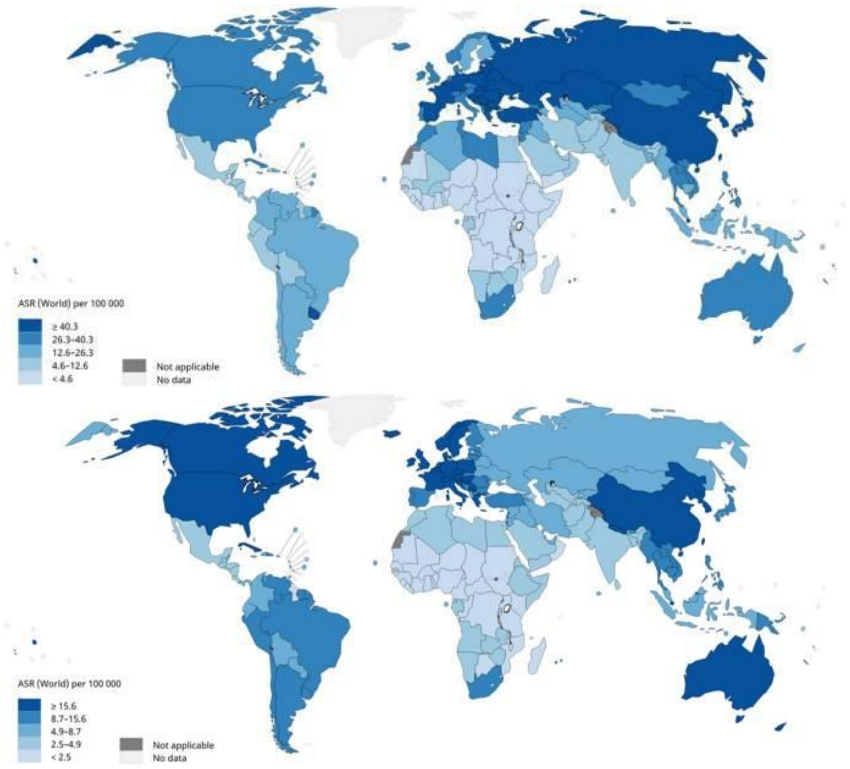
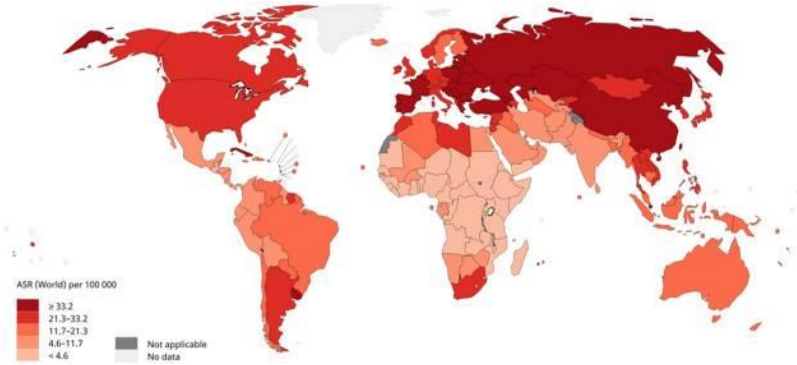


Figure 1. Age-standardized rates for lung cancer incidence worldwide. **Figure 1a**. Shows age-standardized lung cancer incidence rates among men. **Figure 1b**. shows age-standardized incidence rates for lung cancer lung among women—production of graphics: IARC (http://gco.iarc.fr/today), World Health Organization [8].

In the same way, there are global geographic patterns for lung cancer deaths, with a low survival rate and a high mortality rate. Around the world, cancer is estimated to be the leading cause of cancer death in men and the second in women [7]. By 2018, approximately 1.2 million men and 576,100 women had died [8]. It should be noted that the highest mortality rate for men is found in Eastern Europe, Western Asia, and North Africa (see Fig. 2) [8]. In contrast, women's mortality rate is highest in North America, Northern Europe, Western Europe, and Australia (see fig. 2) [8].



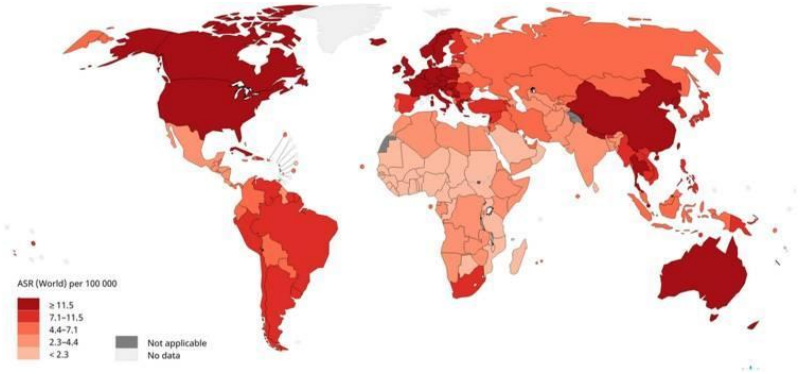


Figure 2. Estimated age-standardized rates (ASRs) for lung cancer mortality worldwide (figure 2a). Shows men's age-standardized mortality rates for lung cancer (figure 2b). The graphics production offers age-standardized lung cancer death rates among women: IARC (http://gco.iarc.fr/today), World Health Organization [8].

1. Diagnosis And Traditional Detection Of Lung Cancer.

Over the years and still today, lung cancer diagnostic techniques have been used for both SCLC and NSCLC. However, it is not easy to define a way that allows early diagnosis and follow-up of adequate treatment. Next, some traditional diagnostic and detection techniques will be named, describing each.

Detection of high-risk groups.

It is a form of diagnosis that allows early detection of lung cancer in treatable or curable stages. High risk includes people with a history of heavy smoking, current smokers, or smokers who quit smoking less than 15 years ago [9]. In 2020, the American Cancer Society predicted 135,720 deaths, and widespread screening may save between 30,000 and 60,000 lives yearly [10].

Radiographic detection

A more effective way of detecting peripheral lung lesions than plain radiography or conventional tomography is computed tomography of the lung (CT). This is a form of detection that has a sensitivity for detecting tumors of approximately 1 cm in diameter; that is, it has more than 109 cells with altered bronchial and vascular epithelial potential [4]. Typically, nodules as small as 1 to 5 mm can be detected, making it a routinely used technology to diagnose lung cancer [11]. Spiral CT can continuously acquire data, resulting in shorter scan time, lower radiation exposure, and improved diagnostic accuracy.

Sputum examination

It is a type of sputum cytological examination of multiple samples that helps to detect central tumors of the largest bronchi. The sensitivity of this test for early lung cancer is between 20 and 30%. Its ability to see premalignant conditions depends on several factors, such as the number and type of cells. It is generally

a complementary test, as it is not accurate enough to be included in the routine examination of a patient with suspected lung cancer [12].

Bronchoscopy and biopsy of lung tissue

One of the most widely used diagnostic tools is white light bronchoscopy, which is used to obtain a definitive histological diagnosis of lung cancer. However, bronchoscopy has significant diagnostic limitations since the visualization or detection of small squamous lesions requires a high level of training. Fluorescence bronchoscopy addresses a solution to this limitation where a photodynamic laser diagnosis system is developed using the fluorescence of drugs for tumors at a wavelength of 630 nm [13].

Although lung tissue biopsy is the most invasive detection system, it is considered the gold standard for confirmation of cancer. Specimens for this test must have sufficient tissue material to allow identification of the cancer subtype by histopathologic procedures. To confirm the early diagnosis, the initial biopsy must be performed correctly to avoid complications and delay in starting treatment due to repeat examination [4].

2. Artificial Intelligence For Early Detection Of Lung Cancer.

As seen in the description of the procedures traditionally used to detect lung cancer mentioned above, these are expensive, prone to complications, require more tests, and affect the patient's quality of life. Therefore, there is an urgent need to generate new early detection and diagnostic methods. Currently, several approaches have been made through artificial intelligence (AI).

In a study by Goncalves et al. in [14], the opportunities for early lung cancer diagnosis through AI-assisted detection of incidental pulmonary nodules (IPN) are described. Currently, there are large volumes of chest images, chest computed tomography, and chest X-rays, which are obtained through occupational health checks, annual checks, immigration checks, and tuberculosis detection, among others, which are not being used. AI allows new and essential information from the large amount of data received in the daily health services [14]. Therefore, when used, it demonstrates greater precision and automatic identification of pulmonary radiographic lesions in captured images.

Like, accurate identification of potential IPNs on CT scans that are taken for other reasons. The performance of a diagnosis of this type is approximately 94.4%, providing support to radiologists with an 11% decrease in false positives and 5% in false negatives. This means that the AI can provide a tool that reviews each examination obtained in a medical control search for possible pulmonary nodules. This offers the possibility of strengthening the medical infrastructure and improving the ability of doctors to interpret images. A tool with great potential to reduce deaths due to late diagnosis, especially in low- and middle-

income countries with socioeconomic, genetic, or infrastructure risk factors [14].

In another similar study conducted by Tunali et al. [15], medical imaging is also defined as a standard of care for early detection, diagnosis, treatment planning, monitoring, and guided interventions for patients with lung cancer. This is made possible by the digital storage of medical images in a standardized format that can be easily accessed and used for both qualitative and quantitative analysis. Radiomics has emerged as a research field that allows stock photos to be converted into quantitative image-based data. Likewise, it can merge with other data sources to later be analyzed by artificial intelligence methods. This is how radionics captures biological and pathophysiological information to generate rapid and accurate non-invasive biomarkers for predicting lung cancer risk.

In a final study [16] relevant to the purpose of this article, written by Ueda et al., an investigation is made of the performance of physicians with different levels of experience in thoracic radiology when using computer-aided detection (CAD) software—based on AI. This software can detect lung cancer nodules on chest radiographs from multiple vendors. The images used in the study were collected from an institution between July 2017 and June 2018; this database contained 59 images with the presence of lung cancer nodules and 253 standard images. The results increased the readers' sensitivity [from 0,47 to 0,60], especially in general practitioners. AI-based software like these can improve doctors' ability to detect lung cancer nodules on chest X-rays.

3. Final thoughts and conclusions.

With the ongoing changes in healthcare and the challenges linked to unmet needs for health issues, in addition to the devastating effects of the recent pandemic on society, it is essential to look at ways to unlock opportunities through AI. Using AI-based technologies to evaluate the different types of existing lung images can improve the accuracy of identifying lung cancer in its early stages. A patient must be diagnosed early so that the chances of cure and survival are higher. This regains particular importance in low- and middle-income countries such as Latin America, where most patients are diagnosed at an advanced incurable stage.

Likewise, as observed in the studies mentioned above, where AI-based technologies are used, early diagnosis reduces the economic burden by optimizing the use of health resources. Although AI still presents fears and challenges, it is urgent to incorporate a tool into the health system that allows early diagnosis. AI is a non-invasive tool that enables clinical decision support for radiologists, oncologists, and general practitioners. It has also been shown that, although it has limitations, it is also beneficial in the continuous process of lung cancer care, including risk prediction, prognosis, and response to treatment.

SOURCES

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