
Tuberculosis And Its Treatment

Introduction

Tuberculosis is still counted as one of the deadliest diseases worldwide despite its well-documented disease prevention and cure. People who live in countries like sub-Saharan Africa, South East Asia, the Baltic States, and Russia have more impact on Tuberculosis than the white people countries. It is found out that people who are living in poor conditions such as hostel dwellers, street dwellers, alcoholics and drug misusers are more prone to TB infection. Missed diagnoses or delayed diagnosis leads to more TB patients every year. Moreover, the leading cause of TB occurrence in people who are already affected by HIV/AIDS leads to higher mortality rates worldwide. The hospitals admit a large pool of tuberculosis patients every day but due to limited available staff, resources and a wide gap between the technological advancement and its usage/availability, people are struggling a lot especially in developing countries.

The TB diagnosis methods include molecular analysis and bacteriological culture but most of the methods cost a lot in developing countries. However cheap and popular diagnosis is reported to have sensitivity issues. This paper presents an automatic detection of tuberculosis in chest radiographs. The cheapness of the imaging technique has attracted most of the researchers to write algorithms on TB chest x-ray. Therefore, for the tuberculosis diagnosis, the CNN technique was demonstrated. Convolutional Neural networks proved to be influential techniques when it comes to image classification. CNN is the class of deep learning and a supervised learning tool that has attained results in a wider range of machine learning tasks. It is highly dependent on datasets size and quality. Earlier data scientists experimented on different classification techniques such as Support Vector Machine, Multi-Layer Perceptron (MLP), etc. But due to the powerful structure of CNN and high accuracy in image processing, most researchers started implementing CNN in their research. CNN has special inbuilt functionality to extract the automatic features from the image which makes it unique among various algorithms. Hence, CNN based algorithm is used for medical analysis and showed excellent performances in the breast cancer classification, organ and tumor segmentation. The datasets are downloaded from Kaggle. "The Shenzhen X-ray set" and "Montgomery County X-ray Set."

The x-ray images were distinguished with normal and abnormal tuberculosis CXR. Keras library is used to build a CNN. Initially, datasets were pre-processed manually. Next, the model was built layer by layer which contains 5 layers i.e. input, convolution layer, pooling layer, fully connected layer, and output layer. The ReLU activation function was used in this model. Following, the model is compiled with three parameters, 'Adam' optimizer, `categorical_crossentropy` for loss function and accuracy metric. To train the model, 70 % for training data, 20 % testing data and rest 10 % for validation data. The model was set to 30 epochs, 20 batch size and learning rate was set to 0.001. The structure, methods, and results obtained will discuss in detail in the following section. The document is divided into the following sections. Section 1 describes the background of Tuberculosis. Section 2 presents the relevant related works from other research papers. Section 3 explores the datasets, methodology adopted in detail and practical approach to our experiments. Section 4 explains the result obtained and a summary of experiments outcomes. Lastly, the paper will discuss the overall

performance of the network and the possible scope of improvement in the future.

Background

Tuberculosis which is also known as "TB" is a bacterial infectious disease that causes illness and death amongst people around the world every year. Tuberculosis is an airborne bacterial infection that can be exhaled by normal people through coughing, sneezing, laughing or maybe singing. The bacteria called *Mycobacterium tuberculosis* is the main origin of tuberculosis infection. TB is mostly found in low and middle-income countries such as India, Bangladesh, China, Indonesia, The Philippines, Pakistan, Nigeria, and South Africa.

Treatment of tuberculosis is highly dependent on which stage it is diagnosed. In most cases, TB majorly affects the lungs of a person, but it can also infect other organs as well. The most common symptoms of TB are cough, sneeze or spit and TB can also be spread from person to person through the air.

Tuberculosis is differentiated with latent, military and active TB and different symptoms are identified for these three stages. Latent TB doesn't spread infection but on the other hand, if active TB left untreated then it can take a person's life. Active TB bacteria tend to rapidly multiply and can easily transfer to other organs as well. Miliary TB is the rare form of TB in which TB bacteria will go into the bloodstream. Miliary TB is quite dangerous because the bacteria quickly flow into the blood cells and affect multiorgan simultaneously. Sometimes people who suffered from miliary TB do not show any symptoms and their x-ray reports may be normal. The only way out to know about miliary TB is to get TST (Tuberculin skin test) or (interferon-gamma release assay (IGRA) test done on the patient. In latent TB, people don't get infected easily because the immune system is enough to build around a defensive barrier around the infection but can pass the infection to others. Inactive TB, the immune system is not powerful enough to bypass the infection. People who have already affected by other diseases such as HIV/AIDS and Smokers are at a high-risk factor for having active TB. Approximately one in ten people having latent TB. Around 1 in 10 people have latent infection and more than 50% of people killed with untreated latent infection.

Tuberculosis is not easy to catch. Firstly, one who has low immunity is at higher risk to get infected with TB and secondly, normal people working with a TB infected person have a high chance to catch TB infection. Besides, there are some common causes of tuberculosis i.e. already infected with diabetes, people who live in overcrowded housing, rely on alcohol and drugs, some other prolonged diseases or ongoing medicines with some other diseases which will make their immune system weakened and more prone to catch TB infection more easily.

The main symptoms of active tuberculosis comprise of weight loss, prolonged cough, high fever for a long duration, persistent cough, it may contain blood or phlegm, fever, tiredness, loss of appetite, weight loss, Sweating (particularly at night), Chest pain, etc. Early TB diagnosis and got appropriate treatment for at least two weeks are no longer contagious. TB has sometimes no symptoms, minor symptoms or negligible symptoms, for some people symptoms develop between 1 or 3 weeks and symptoms can take up to several months or years after a person got infected. TB can be fatal if left untreated. Even though it mostly affects the lungs area, but it can blowout to the blood which can cause various complications like spinal pain, joint damage, liver or kidney damage, heart disorders or meningitis.

As per the World Health Organization (WHO, 2018), TB comes in the top 10 rankings which caused death worldwide and also a major health concern. WHO is publishing reports globally each year since 1997 on TB. If we talk about current year TB data, the death caused by TB is still leading worldwide. In 2017, around 1.3 million deaths were estimated included HIV diagnosed and non-HIV diagnosed people globally. Also, 5.8 million were men, 3.2 million women, and 1.0 children were reported. Overall 90% are adults and among 90%, 9% were people living with HIV (72% Africa) and 2/3 in other countries such as India (27%), China (9%), Indonesia (8%), Philippine's (6%), Pakistan (5%), Nigeria (4%), Bangladesh (4%) and South Africa (3%). About 1.7 billion people which is 23% are estimated to have latent TB infection. Fatality rates are higher for people effected with HIV-TB who are on TB medicines but not antiretroviral therapy. Sometimes people who are affected with both HIV and TB can have good access to get treated with HIV but dying from untreatable forms of TB such as multidrug-resistant TB especially in developing countries. As per the WHO report in 117 countries worldwide, treatment with MDR-TB seems to be difficult in developing countries as treatments are limited and pretty expensive too, medicines recommended by doctors are not available most of the time. DOTS is a short-term course to control TB which is recognized worldwide. Around 36 million TB patients between the years 1995 and 2008 were successfully treated with the DOTS program and 6 million deaths were prevented. But still, we are lacking the target of TB-free world status.

Moreover, there is no vaccine worldwide which is effective, even Mycobacterium Bovis BCG, does not prevent pulmonary TB in adults but it protects infants from all kind of TB diseases. If a patient is not fully treated with pulmonary TB disease than it can lead to long-term damage to other body parts such as lungs, brain, liver, heart, spine and many more. In the last four years, valuable research has been done but still, there is a lot to be more discovered to effectively decrease the occurrence of tuberculosis.

Treatment depends upon the stage of TB like a person has active or latent TB. Doctors recommend 6-9 months antibiotics if the patient has latent TB infection. People suffering from active TB need to take 6-12 months a combination of medicines. These are the first-line treatment which includes isoniazid, rifampicin, ethambutol, and pyrazinamide for pulmonary affected patients. Whereas, some people require a hospital stay for a short time. It is essential to complete the full course of medicines as per doctor's advice. Moreover, it is much more difficult to treat TB if people stop taking treatment in between and it can be fatal at any stage.

Even the person should make sure that he is receiving the right amount of treatment. TB tests can be determined using a skin or blood test. The skin test involves injecting fluid into a person's lower arm. The fluid is known as tuberculin. If a person develops swelling within 48-72 hours than the test results outcome can be positive. A chest x-ray and sputum test can also determine the person contains active TB or not. Seeking the advice of a doctor is always a wise decision in any case of symptoms of TB.

In high-incidence countries, TB control is highly dependent on patients who are self-presenting to healthcare. Several tests required patient attendance regularly which makes most of the individuals non-compliance to hospital visits because most people couldn't afford the traveling cost. Mostly TB laboratory in underdeveloped cities is of single-room, poorly maintained microscopes, lack of staff, electricity and clean water. In developed countries, confirmation of TB is usually by culture followed by drug susceptibility testing (DST) and identification of the MTBC strain. Though, these tests are really expensive requiring specialized equipment and

highly trained doctors.

There are several ways to prevent spreading TB to other people from developing active and infectious TB disease. Firstly, the use of respirators and masks which help to minimize the risk of circulation of germs to other people. Secondly, a BCG tuberculosis vaccine is not effective, but it does a little contribution to safe people from TB infection. Thirdly, spreading awareness among common people is necessary because there are many reasons to get TB infection and cure for the same.

Pulmonary Tuberculosis (TBC)

The word "pulmonary" means anything relating, affecting, attacking or occurring in the lungs. Pulmonary tuberculosis is an airborne infection caused by *Mycobacterium tuberculosis*. PTB can be life-threatening if it left untreated. In most cases, it is curable, if diagnosed early and the patient should need to complete the full 6-month course of antibiotics. This deadly growing disease is mostly found in women, children and already affected by HIV/AIDS. As per WHO, around 1.8 million cases are coming up every year infected with *Mycobacterium tuberculosis*. Major complications of pulmonary tuberculosis include hemoptysis, pneumothorax, bronchiectasis, extensive pulmonary destruction, malignancy, and chronic pulmonary aspergillosis. Symptoms in pulmonary TB can vary from patient to patient and can develop slowly depending on each body system. The main symptoms are continuous 3 weeks bad cough, chest pain, coughing up blood or phlegm from the lungs, breathlessness and in the later stage, it can also attack other organs of the body. So far, clinicians have found out that there is a lack of antibiotics medicine for pulmonary TB and people are not effectively cured with antibiotics medicines. Although there are so many new diagnostic methods out there there is a need to improved TB treatment strategies.

Literature Review

Tuberculosis is an infectious disease among adults. Around new, 10 million people are getting affected with TB each year and approximately 2 million dying each year as a result. Particularly, pulmonary TB is on the rise and especially people already infected with HIV. Development of new methods and technologies has been available for TB diagnosis whether it is traditional or modern, but each method has its drawbacks either it may time consuming or costly. Numerous approaches help in analyzing tuberculosis diseases in the early stages. One of the methods is Sputum smear microscopy analysis. This method can reduce the heavy-duty work of doctors and technicians. To avoid overload work in hospitals against tuberculosis disease. Researchers invented automatic microscopy screening for analyzing mycobacterium image, but the process is not that easy and still, researchers are trying to get the best outcome with image processing, color segmentation, and classification technique. As discussed earlier, this method works best for the early detection of mycobacterium tuberculosis. It divides the classification method into two groups, tuberculosis bacteria or not.

The geometry feature and backpropagation method are used in this research. The dataset used in this is already taken as a binary image. Microscopy screening is processed with binary data to find the mycobacterium shape feature and neural network is applied for classification. The neural network seems to give a satisfactory result, but it is suggested to use when tuberculosis is on the 1st stage. Furthermore, color segmentation is recommended to get better results.

Several studies used machine learning techniques to describes a signal generation mechanism for biosensing for automatic diagnosis of TB called Plasmonic ELSIA which offers a low-cost, simple, rapid and portable platform. This study is based on two research. Firstly, computational intelligence used with Plasmonic ELISA to detect TB. Secondly, the classification performance was compared with different types of classifier. The sample was segmented by moving k-mean clustering from an optical microscope for the detection of tuberculosis bacteria. For improved and robust segmentation both RGB and C-Y color were utilized. The hybrid multi-layered perceptron network (HMLP) is used to detect tuberculosis bacteria. The final result's accuracy is pretty impressive. However, when we talk about simple, rapid and portable detection of TB than lateral flow tests (LFTs) are much famous. To collect the multiple detection results of color variation, a smartphone is used.

The synthetic biological samples were used for the plasmonic ELISA as well as they used real samples too such as urine and saliva because real-time testing is low-cost, faster without experts. Authors, presented an automatic detection of pulmonary tuberculosis through chest x-rays. This paper includes all the research and methods for the diagnose of pulmonary TB. Chest x-rays are a comparatively less costly technique for the detection of TB in developing countries. But for the large population, it is quite difficult to do everything manually. That is why Computer-aided diagnostic systems are used to detect TB in X-rays. Chest radiography aims to detect and monitor respiratory infections like TB and also examine other respiratory problems.