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Comparative Study of Global Severity of Tuberculosis

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***Abstract*—Tuberculosis (TB) is the infectious diseases in the world. It caused by Mycobacterium tuberculosis (M.TB). According to world health organization, One third of the world's population is infected with TB. TB Diagnostics is a very challenging job, due to limited suitability of today's available techniques. It is hard to detect TB at an initial phase of infection. Due to this it delay for treatment and complexity of the disease is increased by multiple drug resistant TB (MDR-TB) strains. There is a necessity of easy and efficient technique to detect TB at an early stage. The aim of this paper is to study the severity of tuberculosis and review the some available diagnosis technique of tuberculosis.**

***Keywords*—M.TB, Mycolic Acid, PTB, EPTB, Smear microscopy, Biosensors.**

I. INTRODUCTION

Technology plays a vital role in our lives. We achieved a lot with the help of technology. In medical most of the technologies were built to detect and prevent some diseases. Till some diseases are under development. One of the diseases is Tuberculosis.

Tuberculosis (TB) has been a major public health problem, From many decades, TB has continued to pose a significant threat to human health especially, in developing countries, like India and sub-Saharan Africa, it is one of the most dreadful and prevalent diseases affecting members from all age groups [1].

Tuberculosis is an infectious disease caused by the Mycobacterium tuberculosis (MTB). Mycobacterium tuberculosis has a waxy coating on its cell surface due to the presence of mycolic acid. Mycolic acids are an important class of compounds, mostly found in the cell walls of a group of bacteria known as mycolata taxon, represent by bacteria of this group, the Mycobacterium tuberculosis (M. TB.), which is responsible for the disease known as tuberculosis (TB)[1][2][3]. Mycobacterium tuberculosis is a Gram-positive bacterium [4]. TB is spread from one person to another through the air. One gets TB by breathing in TB bacteria that are in the air. Bacteria get released into the air by someone who already has the bacteria in their body.

The two types of medical appearance of tuberculosis (TB) are pulmonary TB (PTB) and extra pulmonary TB (EPTB) [13]. PTB refers to TB involving lungs organs [13]. EPTB refers to TB involving organs other than the lungs (e.g., pleura, lymph nodes, abdomen, genitourinary tract, skin, joints and bones) [4, 13].

Tuberculosis (TB) is categories as active disease or latent infection. Latent TB means bacteria are in inactive stage and no symptoms of TB found in body. Latent TB is not spreadable but it may convert active in future. Active TB means TB bacteria get increase in body and develop the symptoms of tuberculosis. If lungs get infected with active TB, one can easily spread the disease to others [5]. The most common form of active TB is lung disease, but it may invade other organs, so-called "extra pulmonary TB"[5].

Early diagnosis of active tuberculosis (TB) remains an indefinable challenge, especially with dispersed TB and HIV co-infection. Due to the complications of a proper treatment in time and issues like multiple drug resistance and other related infections that decrease body immunity, like HIV. Current technologies for diagnosis are either too insensitive, too laboratory intensive or utilize expensive detection modules, which are all challenges in resource poor settings [24]. Considering the fact there is a strong need to develop alternative, simpler and lower cost techniques for TB diagnosis [5].

The aim of this paper is to study the severity of tuberculosis and review the available diagnosis technique of tuberculosis. The content of the paper is organized in four sections, section 1 dealt with introduction, section 2 deals with year wise statistics, section 3 deals with currently available diagnosis technique of TB, section 4 deals with TB diagnosis using biosensors and section 5 deals with conclusion and references.

II. YEAR WISE STATISTICAL REPORT

Worldwide, TB is the ninth leading cause of death and the leading cause from a single infectious agent, ranking above HIV/AIDS [6]. TB is present in all regions of the world and

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millions of people were infected by TB in every year [6]. Table I shows the global estimated TB cases with Adults, Children, Male, Female, MDR-TB and HIV+TB from 2011 to 2016 [7, 8, 9, 10, 11, 12, 13].

Fig. 1 shows the graphical representation of global estimated ratio of male and female TB cases. Fig.2 shows the graphical representation of global estimated ratio of adults and children TB cases. Fig. 3 shows the graphical representation of global estimated ratio of MDR-TB and HIV+TB cases. An estimated millions of people fell ill with TB: 90% were adults, 65% were male, and 10% were people living with HIV.

TABLE I. WORLD ESTIMATED TB CASES

Year	World Estimated TB Cases							
	TB Cases	Adults	Children	Male	Female	MDR-TB	HIV	HIV + TB
2011	8.7 million	8.2 million	0.5 million	5.3 million	2.9 million	0.06 million	2.2 million	1.0 million
2012	8.6 million	8.0 million	0.6 million	5.1 million	2.9 million	0.45 million	2.2 million	1.1 million
2013	9.0 million	8.4 million	0.6 million	5.1 million	3.3 million	0.48 million	2.1 million	1.1 million
2014	9.6 million	8.6 million	1.0 million	5.4 million	3.2 million	0.48 million	2.1 million	1.1 million
2015	10.4 million	9.4 million	1.0 million	5.9 million	3.5 million	0.48 million	2.1 million	1.2 million
2016	10.4 million	9.4 million	1.0 million	6.2 million	3.2 million	0.49 million	2.1 million	1.4 million

Fig. 1. **Gender Wise TB Cases**

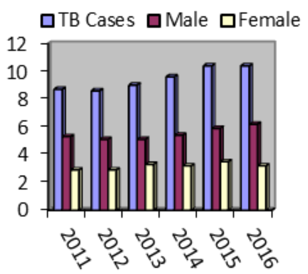


Fig. 2. **Age Wise TB Cases**

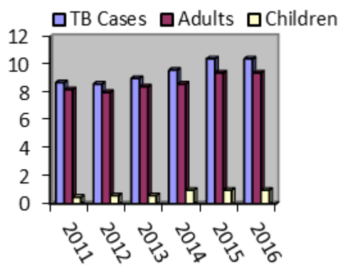


Fig. 3. **MDR and HIV TB Cases**

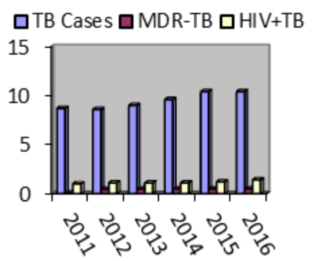
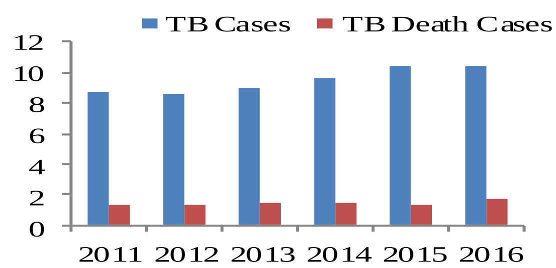


Table II shows the global estimated TB cases from 2011 to 2016 [7, 8, 9, 10, 11, 12]. Fig. 4 shows the graphical representation of global estimated TB cases.

TABLE II. WORLD ESTIMATED TB CASES

Year	World Estimated TB Cases	
	TB Cases	*TB Death*
2011	8.7 million	1.4 million
2012	8.6 million	1.3 million
2013	9.0 million	1.5 million
2014	9.6 million	10.5 million
2015	10.4 million	1.4 million
2016	10.4 million	1.7 million

Fig. 4. **World Estimated TB Cases**

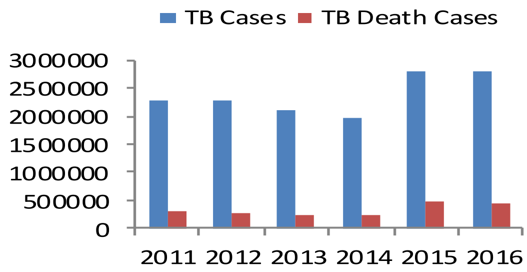


India is the country with the highest burden of TB. Table III shows India estimated TB cases from 2011 to 2016 [14, 15, 16, 17, 18, 19]. Fig. 5 shows the graphical representation of it.

TABLE III. INDIA ESTIMATED TB CASES

Year	India Estimated TB Cases	
	TB Cases	*TB Death*
2011	2300000	300000
2012	2300000	270000
2013	2100000	240000
2014	1980000	220000
2015	2845000	480000
2016	2790000	423000

Fig. 5. **India Estimated TB Cases**



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Tuberculosis has been observed to increase in conditions of poverty at the society and community level. The main aspects include under nutrition, poor living conditions (overcrowding, inadequate ventilation) and access to adequate health care facilities [20]. The undernourishment together with limited access to adequate health care increases the risk of the active tuberculosis disease and also that inadequate ventilation increases the risk of emergence of the latent tuberculosis infection (LTBI) [20].

The most of the countries are affected by tuberculosis; especially it is prevalent in sub-Saharan Africa. The rate of tuberculosis is 860 per 100000. The primary reason of the TB in Africa is because of the link between TB and the human immune deficiency virus and the acquired immune deficiency syndrome (HIV/AIDS). HIV-positive people are also more likely to develop TB when newly infected or re-infected with M. tuberculosis [21]. Another reason of the TB is Mining production. Atmosphere inside the mines create a high-risk for TB transmission, subsequent part from silica dust exposure increases the risk of pulmonary TB, particularly in gold mines, as well as confined and poorly ventilated environments conducive to transmission [22].

India is also a highest burden country of TB. In many Indian cities the air quality index are the subject to grow the TB infections. Indian Cities like Delhi and Kanpur have seen higher incidence of respiratory illnesses and compromised lung functioning that are directly linked to the increased particulate matter in the air. As per the furin "anything that affects local immunity of the lung or overall immunity of the body, will increase the risk of developing TB [23]. Smoking and most use of cooking fuels will raise the risk of TB. Numerous studies have associated air pollution and there is a plausible mechanism of action" [23].

III. CURRENT TB DIAGNOSIS TECHNIQUE

From last few decades most of the effective diagnostic techniques have been developed that are cheap, robust and can achieve high performance.

Conventional tests for the diagnoses of TB are [24, 25, 26].

A. *Smear Microscopy*

In resource poor countries to detect pulmonary tuberculosis smear microscopy has been used, which is conventional and primary method. For the detection of acid-fast bacterium such as M.TB bacterium, smear microscopy is simple, rapid, inexpensive and relatively easy to perform. minimum of 1 x 104 bacterium per ml of sputum is required in Ziehl-Neelsen staining method. However, sputum smear microscopy has significant limitations in its performance when the bacterial load is less than 1 x 104 organisms/ml in sputum sample [27,28].

B. *Radiography*

Radiography uses X-rays to visualize the internal structures of a patient. Chest X-ray (CXR) is a rapid imaging technique that allows lung abnormalities to be identified. CXR is used to diagnose conditions of the thoracic cavity, including the airways, ribs, lungs, heart and diaphragm. CXR has been one of the primary tools for detecting tuberculosis (TB), especially pulmonary TB. For many years, WHO has recommended CXR as a diagnostic tool to be used as a complementary part of the clinical diagnosis of bacteriologically negative TB. However no abnormalities are definitive of TB, therefore the specificity is low; special equipment (with adequate input power) is needed, trained personnel are required to operate the machine and interpret the results [29]. For detection of pulmonary tuberculosis in digital chest X-rays, a method was developed and tested by combining shape and texture features to classify CXRs into two categories as TB and non-TB cases. The algorithm uses shape features to describe the overall geometrical characteristics of the lung fields and texture features to represent image characteristics inside them [30].

IV. TB DIAGNOSTIC USING BIOSENSORS

A. *Electrochemical and Electrical Biosensors*

Now a day for detection of large number of diseases the most popular Electrochemical and electrical biosensors are used [31, 32, 33]. The mechanism of detection depends on specific changes in electrical signals at a surface-functionalized electrode by either chemical reactions or physical interactions [34]. There are main two types of biosensors [34].

1) Electronic Nose-Based Biosensors:

Electronic Nose-Based Biosensors are designed to identify changeable substances produced by TB in liquid medium [34]. In an electrochemical transducer based system metal oxide semiconductors or conducting polymers coupled to the transducer are used. It comparatively less sensitive causes a major limitations for applying them as a permanent diagnosis solution to TB diagnostics.

2) Nanowire-Based Biosensorsor:

They are most conspicuously illustrated by silicon nanowires that run as field effect transistors [34]. However, the delicate surface functionalization and nature of silicon nanowires, makes it technologically more challenging to design and implement these types of sensors [35].

B. *Optical Biosensors*

It involves determining changes in light absorption between the reactants and products of a reaction, or measuring the light output by a luminescent process [36].

Fibre Optic Biosensors:

Optical fiber-derived devices which use optical field to measure biological species such as cells, proteins, and DNA.

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Fiber optic biosensors are based on the transmission of light along silica glass fiber, or plastic optical fiber to the site of analysis. It transmits light on the basis of the principle of total internal reflection (TIR). Fiber optic biosensors are analytical devices in which a fiber optic device serves as a transduction element. The transmitted light interacts with the fibres' surrounding, causing an energy flow that could activate fluorophores bound to the outer surface of the fibre tube. The emitted light from the fluorophores can then also be detected using a spectrophotometer. These sensors can be perfect to detect specific pathogens [37, 38].

V. CONCLUSION

In every year millions of people were infected by TB. It present in all regions of the world. One third of the world's population is suffering by TB. Worldwide Tuberculosis is the ninth leading cause of death from single infectious agent, ranking above HIV/AIDS. Due to the complexity of a proper and inexpensive techniques and treatment in time, TB remains major unresolved global health problem. Current diagnostics techniques are laboratory based or used expensive tools and are insensitive. For diagnosis most techniques used sputum samples, due to its high viscosity and sticky nature is very difficult to work with. Most of the biosensors discussed in the present review are still at the developmental stage and lack of clinical validation with real TB samples from patients. As per the aim of WHO to completely destroy TB from world by 2050, development of proper techniques for early and accurate detection of TB is desirable. For effective diagnosis of TB in resource-poor settings the field of biosensors has very strong potential.

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