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| **Title:** | | Development of AI tool for radiographic detection and diagnosis of TB. | | |
| **Purpose:** | | Discussion | | |
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| **Abstract:** | In 2017, 27% of the estimated 10 million global Tuberculosis (TB) cases developed in India. In the past few years, India has been actively implementing multiple strategies for reducing the burden of TB, including the web-based reporting system, the national TB prevalence survey, and the rollout of TB service delivery from all HIV clinics. An early adoption of Computer Assisted Diagnosis (CAD) systems based on artificial intelligence (AI) technologies for TB detection in India will synergize with the current endeavours to close the gap in TB control and will help global fight against TB and use of AI in the field of population health.  This proposal proposes development of AI tool for radiographic detection and screening of TB. |

# Overview:

Machine learning (ML) techniques have been used world-wide for improving public health through development of better prognostic, diagnostic and predictive models. The application of ML technologies in healthcare has increased exponentially. In 2017, 27% of the estimated 10 million global TB cases were reported from India. There is a need to detect the missed cases by early adoption of CAD systems based on artificial intelligence (AI) technologies for TB detection. This will synergize with the global endeavours to close the gap in TB control. .

ICMR has access to large volume of high quality clinical data from various extramural and intramural programs. The data ranges from text based patient profiles to complex molecular sequences and structures and images. The proposal focuses on development of the AI tool for radiographic detection and screening of TB and will nucleate advance machine learning and analytics on data generated from various TB research activities of ICMR.

There is approximately only one radiologist for every 100,000 population. In Zambia, also one of the high-TB/HIV-burden countries, there are only two radiologists in the country of over 11 million population.

# Relevance

The study is of immense relevance in view of following:

1. AI technologies, including deep learning (DL) and natural language processing (NLP), draw attention of many public health professionals as it can overcome the shortage of healthcare professionals.Based on the study conducted by the Center for Internet and Society, India (CISI), it is evident that India has a well-established infrastructure for integration of AI into the Indian health technology infrastructure.
2. AI has gained a platform in India to enable the scientific community to deal with challenges related to cognitive disorders and social issues through the use of psychological tools & batteries, early diagnosis and better therapies, intervention technologies and rehabilitation programs.
3. India has conducted mobile TB diagnostic van intervention using X-ray diagnostic vans and sputum microscopy for diagnosis of TB in tribal population which has resulted in increase in detection and reduction in out of pocket expenditure of patients . The AI technique can help in diagnosis of TB cases in difficult o reach areas in India and other low income countries.
4. Also National TB prevalence survey is being conducted covering 500000 population in entire country using mobile X-rays in field. The AI x-ray diagnosis would be of immense use in field diagnosis of TB and can be used across the globe in other countries as well where there are limited resources and expertise.

# Impact:

Over the past two years from 2016 to 2018, ICMR-NIRT has been conducting the TB surveillance in Tiruvallur region where more than 69,000 x-rays have been taken and in those who were symptomatic, the sputum was collected and investigated for the presence of MTb in the sample collected. These radiographs have been stored as digital x-rays and can be used for the study.

Multiple DL algorithms for detecting and quantifying critical findings from medical images with the ability to explain the model output will be developed. By leveraging our technologies, the team will develop a CXR triage model to automatically determine if a CXR is normal or not. With more realistic data collected and labelled by TB experts with experience in TB care in India, it will be possible to quickly develop an algorithm that works best in the Indian setting.

# Existing work

ICMR, India has extensive clinical expertise in various communicable and non-communicable diseases. ICMR, India also has expertise in data management and analytics through Data Management Laboratory (DML) under the division of Informatics Systems and Research Management (ISRM). The division has developed data management and analytics portals for various program of ICMR such as Antimicrobial Resistance Surveillance Network, Etiology and Prevalence of Hearing impairment, Dialysis Outcome Registry, Indian Rare Disease Registry, Implementation research in mental health, Leprosy data management portal, Childhood Associated Mortality Survey, Indi-cleft etc. In addition, ICMR also has various other data source of immense National importance like NNMB and NCRP. Integration of these data sources with communicable and non-communicable disease data sources using AI will identify hidden correlation and provide necessary evidence for developing programs to improve public health.

The normal X-ray, X-rays taken from TB patients at the Tiruvallur TB Surveillance during 2016- 18 would be utilized for the learning by the software. Besides, collection of X-rays from other hospitals would also be explored.

# Feasibility

ICMR, India has extensive clinical expertise in developing AI tool for diagnosis or screening of various communicable and non communicable diseases and would be able to lead the study.

Model Development:

ICMR intends to use the AI lab for identifying better diagnostic markers from the genomics, proteomics and image data generated by various programs of ICMR. For example, digital X-rays and clinical data generated from Tiruvallur TB Surveillance and other TB surveillance programs of ICMR can be used for real-time prediction of TB cases. Further the digital and clinical data on TB can be modelled to develop automated image annotation tools to aid diagnostic decision making for the clinicians. Using AI techniques mapping of clinical and case prevalence data on GIS can be of immense importance in understanding transmission dynamics to TB and Leprosy.

The model will be developed in following stages -

* **Stage 1:** Building an algorithm that interprets chest plain radiography and detects signs of pulmonary tuberculosis
* **Stage 2:** Building a more comprehensive algorithm that combines imaging and other clinical information to provide more reliable prediction for diagnosis of tuberculosis
* **Stage 3:** Expanding the model to be used in detection of other pulmonary diseases

Each stage will consist of three sub-phases;

* **Phase 1:** Retrospective data collection and model building
* **Phase 2:** Prospective validation and user feedback
* **Phase 3:** Full deployment of the system and continuous improvement

# Expected Outcome:

Development of a Cost-effective AI tool for radiographic diagnosis for early detection of TB.

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