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AI - DRIVEN DETECTION OF TUBERCULOSIS IN PATIENTS WITH HYPERGLYCEMIA AND COMORBIDITIES




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ЁНДОШ КАСАЛЛИКЛАР ВА ГИПЕРГЛИКЕМИЯСИ БЎЛГАН БЕМОРЛАРДА ТУБЕРКУЛЁЗНИ СУНЪИЙ ИНТЕЛЛЕКТ ЁРДАМИДА АНИҚЛАШ

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ИСКУССТВЕННЫЙ ИНТЕЛЛЕКТ -УПРАВЛЯЕМОЕ ВЫЯВЛЕНИЕ ТУБЕРКУЛЕЗА У ПАЦИЕНТОВ С ГИПЕРГЛИКЕМИЕЙ И СОПУТСТВУЮЩИМИ ЗАБОЛЕВАНИЯМИ

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Резюме. *Дунё миқёсида аҳоли ўртасида энг хавотирли ўлим сабабларидан бири диабет ва сил касаллиги ҳисобланади. У ОИВдан кейин иккинчи ўринда туради. Қон таҳлили, биопсия ва балғам таҳлили каби анъанавий усуллар мавжуд. Бироқ касалликлар сонини ҳисобга олсак, кўп ҳолларда нотўғри ташхис қўйилган ёки умуман даволанмаган ҳолатлар мавжуд. Технология соҳасидаги ўсиб бораётган ривожланишлар туфайли сунъий интеллект (СИ) сил касаллиги (туберкулёз)ни эрта ва аниқроқ аниқлашда ёрдам бера олади. СИ йўналишида турли усуллар, жумладан, маълумотларни таҳлил қилиш, генетик алгоритмлар, кўп қатламли нейрон тармоқлар ва бошқа инновацион ёндашувлар тиббиёт соҳасида ташхис қўйиш жараёнини яхшилашга хизмат қилмоқда. СИ алгоритмлари кўплаб туберкулёз билан боғлиқ ҳамроҳ касалликларни, масалан, нурли диагностика усуллари орқали ўпка туберкулёзини аниқлаш, Mycobacterium tuberculosis'ни автоматик равишда аниқлаш ва дорига чидамли туберкулёзни ташхислаш учун генетик маълумотларни тўғри таҳлил қилишда самарали натижаларни намойиш этмоқда. Гипергликемия билан боғлиқ туберкулёз ҳолатлари нейрон тармоқлар, табиий тилни қайта ишлаш (NLP) ва конволюцион нейрон тармоқлар (CNN) каби янги технологиялар ёрдамида яхшироқ таҳлил қилиниши мумкин. СИ анти-туберкулёз дори-дармонларининг таъсирини прогноз қила олади, бу эса бемор учун энг мақбул дорини танлашга ёрдам беради. Бироқ, СИ билан боғлиқ айрим муаммолар мавжуд, масалан, маълумотлар махфийлиги, чекланган интернет имкониятлари ва сунъий интеллект бўйича мутахассис кадрларнинг етишмовчилиги. Лекин СИ имкониятларидан фойдаланиш учун қуёш панеллари каби альтернатив ечимлар ишлаб чиқилиши мумкин. Тиббиёт ва соғлиқни сақлаш соҳасидаги сунъий интеллект ҳали ҳам "айсбергнинг учи" ҳисобланади ва энг яхши тиббий ёрдамни тақдим этиш учун кўплаб янги инновацияларни қўллаш имкониятлари мавжуд.*

Калит сўзлар: *туберкулёз, сунъий интеллект, машинавий ўрганиш, соғлиқни сақлаш, дорига чидамлилик, генетик алгоритм, табиий тилни қайта ишлаш, конволюцион нейрон тармоқ.*

Abstract. *In the world, one of the most concerning problems with respect to the population killers is diabetes and tuberculosis. It is ranked 2nd after HIV. There are many forms of conventional methods, such as blood tests, biopsy, and sputum analysis. But considering the amount of cases, there are many poorly diagnosed and untreated. With the growing advancements in the field of technology, AI (artificial intelligence) can help for the early and more accurate detection of TB (tuberculosis). Different methods in AI have paved the way, like data mining approaches, genetic algorithms, neural networks with multiple layers, and many more mentioned, which help in assisting better diagnosis in the medical field. AI algorithms have depicted great promises in the diagnosis of many tuberculosis co- morbidities like pulmonary tuberculosis using radiological methods, automated detection of Mycobacterium tuberculosis, and accurate analysis of genetic data for the diagnosis of drug- resistant. TB associated with hyperglycemia can be better processed with innovative techniques like natural language processing (NLP) and convolutional networks (CNNs). AI can predict the response of anti-TB drugs, which can help formulate the most convenient drug for the patient. There are some challenges that are associated with AI, like data privacy, limited internet access, and a lack of AI-skilled technicians. But solar cells can be considered for the better provision to utilize AI. AI in medicine and the healthcare community is still a tip of the iceberg, and there are many great innovations to exercise the practice to provide the best care*

Keywords: *tuberculosis, artificial intelligence, machine learning, health care, drug resistance, genetic algorithm, natural language processing, convolutional network.*

Introduction: Diabetes is an important risk factor for active tuberculosis (TB) Geric (2023), and its significance is growing in epidemiological studies. A meta-analysis pooling data from 2.3 million people with active TB found that 15.3% of patients had diabetes at the time of diagnosis Jeon (2008), Projections suggest that the global prevalence of diabetes will rise from 463 million to 578 million by 2030 Noubiap(2019) . It is believed that diabetes enhances the risk of TB P.seedi (2019) . Studies have reported a higher prevalence of lower lung lesions in TB patients with diabetes compared to those without K.E Dooley (2009) as well as an increased incidence of cavitary lesions Ak patel (2011). However, other research has not identified significant differences in the radiographic appearance of TB related to diabetes C Perez-Guzman (2000) . One promising approach to resolving these discrepancies is artificial intelligence-based radiographic analysis, called as computer-aided detection (CAD). CAD technology is expected to play an increasingly prominent role in TB diagnostic pathways, especially with its approval by the World Health Organization in 2021 R Ruslami (2010) , which has paved the way for its wider use in chest X-ray (CXR) evaluations. In this report, we use data from a study aimed at evaluating the diagnostic performance of computer- aided detection (CAD) systems in identifying culture-confirmed pulmonary tuberculosis.

Specifically, we investigate whether diabetes status is linked to the radiographic features of

tuberculosis as identified by CAD. Although our previous analysis showed no significant relationship between diabetes and the sensitivity or specificity of two commercially available deep learning-based CAD systems in this dataset.

Research materials and methods: Artificial intelligence (AI) was named by John McCarthy. Illustrated below are some of the methods and materials.

Different methods of AI for diagnosing tuberculosis (table no.1):

AI-based computer-aided detection (AI-CAD) with chest X-rays is seen as a solution to end TB by 2030. The WHO has recommended this technology in 2021, and the partnership has focused on benchmarking for market access. Onno(2023)

Latent tuberculosis infection (LTBI) is extremely challenging, as current tests can't differentiate it from active TB Mycobacterium tuberculosis (ATB). Key challenges include a lack of effective biomarkers and the time-consuming nature of sputum culture, which can't distinguish LTBI and ATB. The potential of machine learning (ML) can help in this situation to improve the diagnosis along with benefits and limitations. Li(2023)

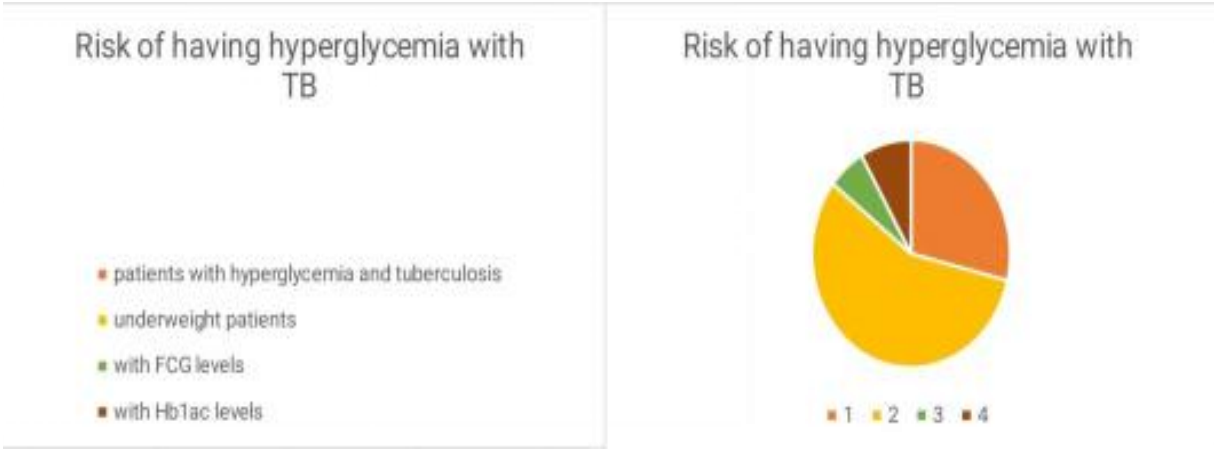
Research objective: Using CAD (Computer-Aided Detection), artificial intelligence-based software identifies radiological abnormalities that are compatible with diagnosing pulmonary tuberculosis on chest X-rays. This CAD uses two artificial intelligence approaches: machine learning and deep learning.

Machine learning is that of AI analysis that is not mainly based on human identification but rather algorithms to evaluate which variables would be important.

Ai-based automatic detection of mycobacterium tuberculosis. Using a convolutional neural network model named tuberculosis AI (TB-AI),which is highly specialized to recognize Mycobacterium tuberculosis. The training set includes 45 samples that include 30 positive cases and 15 negative cases. After training the neural networks by taking 201 samples, it conclusively showed 109 samples positive cases and 93 samples negative cases.

Table no.1 The above-mentioned table no. 1 helps us to understand different methods of AI for diagnosing tuberculosis Meraj (2019)

No.	Method	Outcome
1	A ubiquitous method in medical diagnosis	AI helps the computer mimic human-like actions. This method helps to give a verified database of patients. The outcome is +(positive), - (negative), or uncertain.
2	Data mining approaches	This consists of raw data that is present before the diagnosis. It follows steps like data cleaning, transformation, integration, and reduction. Identification tree (IDT) is generated, which uses average disorder score (ADS). TB uses 12 rules for diagnosis.
3	Neural network with multilayers	Computer model similar to the neural network of the brain. It consists of input, output, and two hidden layers. These parameters are included in demographics, constitutional symptoms, and radiographic findings. The diagnosis accuracy was reported to be 92.30%.
4	Genetic algorithm	It consists of selection, crossover, and mutation. A multilayer neural network was created with two hidden layers, and it divided two types of patients with TB and without TB. The results showed classification with 94.88% accuracy.
5	Artificial immune system	It's mainly applied to problem- solving, like the memory response of immunity. The AIS is used for diagnosing tuberculosis in the similar pattern of immunological response of our body.



a. b.

Fig 1. Risk of developing hyperglycemia in tuberculosis

Assessing after double diagnoses by the pathologist via both microscopes and digital slides, TB-AI shows 97.94% sensitivity and 83.65% specificity; hence, it can be concluded that TB- AI can be a trustworthy support system in the identification of stained TB bacilli and helps in making clinical diagnosis. Note that samples labeled as positive must be examined by the pathologist, whereas samples labeled as negative must be reviewed, and digital slides are qualified. Xiong (2018)

Relevance of using artificial intelligence and genetic data for diagnosis as well as drug resistance prognosis of pulmonary tuberculosis. Sometimes, along with using AI and genetic data, there is a way to diagnose TB. Using a "Deep AMR," which is a deep learning model having a deep denoising autoencoder, to understand the co-current drug resistance of M. tuberculosis compared with the model having conventional machine learning methods that include RIFAMPICIN and ISONIAZID RESISTANCE.

Same way as AI, there is a way to determine the drug resistance of M. tuberculosis strains is through inputting gene sequences, a nd then when compared with 3 deep learning models that are wide and deep neural networks, LR as well as deep multilayer perception were displayed as four forms: **kSdD-WDNN** for detecting the preselected mutations, **SD-WDNN** for detecting single resistance, and **2MD-WDNNs** for detecting common mut ations in multiple resistance. And **MD-WDNN** passed both first-line and second-line drugs. Simultaneously correlated studies done on a friendly online tool called **GenTB,** which was based on genome sequencing to prognose the antibiotic resistance, involved both WDNN and RF algorithms. After testing on 20,408 patients , both Gen TB-RF and Gen TB-WDNN displayed exceptional performance in first-line drugs. An interesting fact is that Gen TB-RF reached the highest prediction for RIF (AUC 96%). Liang (2022)

Risk of having hypertension TB (fig. 1):

In the above, figs. 1a and 1b show us the risk of having hyperglycemia with tuberculosis.

Impact of diabetes on tuberculosis We know diabetes mellitus causes an alteration of the immune system, making the body prone to tuberculosis infection. Diabetic patients with tuberculosis are at greater risk of adverse drug interaction, decreased prognosis, delayed diagnosis, and increased mortality.

Application of AI in treatment of TB in diabetic patients. AI used in different medical imaging— convolutional network (CNN) neural networks and different learning algorithms— caused high accuracy in understanding chest X-rays and CT scans for diagnosing TB.

AI can predict the response of anti-TB drugs. Anti-TB drugs based on genetic, demographic, and clinical data. Optimizing drug dosage by using machine learning models can reduce the risk of drug resistance. Comprehensive Health Management Systems: AI can aggregate information from blood glucose monitors, TB diagnostic tools, and electronic medical records, delivering a holistic approach to the patient's health. This enables a more coordinated approach to managing coexisting conditions.

Patient Risk Assessment: Advanced machine learning models model can assess patient data to classify them into various risk categories, allowing healthcare professionals to focus on those requiring more intensive interventions.

Innovative AI supports in TB and Diabetes Research:

A. Text Analysis Technologies: Tools utilizing natural language processing (NLP) can drive critical insights from unstructured clinical documentation, helping to pinpoint high-risk patients and diagnostic precision.

B. AI-Driven Pharmacological Research: Artificial intelligence streamlines the drug development process by understanding large-scale to discover novel therapeutic compounds, particularly those targeting TB in diabetic patients. (2023)

Challenges in implementing AI for TB and Diabetes Management 1.) Confidentiality and data protection; ensuring patient data privacy is crucial when deploying AI in healthcare. Especially when integrating multiple data sources 2.) Infrastructure and capacity limitations; AI implementation in low-resource settings faces challenges, such as limited Internet access, inadequate health infrastructure, and a lack of trained personnel to operate AI systems. But with the help of solar cells, these barriers can be faced.

Conclusion:

AI enhances TB diagnosis via better imaging, genetic analysis, and a better early drug- resistant case. It provides a better response to treat and reduce drug resistance for those suffering from diabetes. Data privacy

infrastructure limitations are some of the important things to be considered that hinder the utilization of AI so alternative ideas like solar cells can be utilized .

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ИСКУССТВЕННЫЙ ИНТЕЛЛЕКТ - УПРАВЛЯЕМОЕ ВЫЯВЛЕНИЕ ТУБЕРКУЛЕЗА У ПАЦИЕНТОВ С ГИПЕРГЛИКЕМИЕЙ И СОПУТСТВУЮЩИМИ ЗАБОЛЕВАНИЯМИ

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Резюме. *В мире одной из самых тревожных проблем в отношении убийц населения является диабет и туберкулез. Он занимает 2-е место после ВИЧ. Существует множество форм традиционных методов, таких как анализы крови, биопсия и анализ мокроты. Но, учитывая количество случаев, многие из них плохо диагностируются и не лечатся. С ростом достижений в области технологий ИИ (искусственный интеллект) может помочь в раннем и более точном выявлении туберкулеза (туберкулеза). Различные методы в ИИ проложили путь, такие как подходы к интеллектуальному анализу данных, генетические алгоритмы, нейронные сети с несколькими слоями и многие другие упомянутые, которые помогают в содействии лучшей диагностике в медицинской области. Алгоритмы ИИ показали большие перспективы в диагностике многих сопутствующих туберкулезу заболеваний, таких как туберкулез легких, с использованием радиологических методов, автоматизированного обнаружения Mycobacterium tuberculosis и точного анализа генетических данных для диагностики лекарственной устойчивости. ТБ, связанный с гипергликемией, можно лучше обрабатывать с помощью инновационных методов, таких как обработка естественного языка (NLP) и сверточные сети (CNN). ИИ может предсказать реакцию противотуберкулезных препаратов, что может помочь разработать наиболее удобный препарат для пациента. Существуют некоторые проблемы, связанные с ИИ, такие как конфиденциальность данных, ограниченный доступ в Интернет и нехватка квалифицированных специалистов по ИИ. Но солнечные батареи можно рассматривать как лучшее обеспечение для использования ИИ. ИИ в медицине и здравоохранении по-прежнему является вершиной айсберга, и существует множество замечательных инноваций для применения практики, чтобы обеспечить наилучшую помощь*

Ключевые слова: *туберкулез, искусственный интеллект, машинное обучение, здравоохранение, лекарственная устойчивость, генетический алгоритм, обработка естественного языка, сверточная сеть.*