Internship Completion Letter

Kanishka Garjola

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 28 June 2024

Deputy Director General

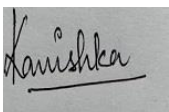522-C, Nirman Bhawan,

New Delhi

Dear Sir,

I hope this letter finds you well. I am writing to express my heartfelt gratitude for the opportunity to intern under your guidance at Central TB Division (MoH&FW). My internship experience has been incredibly enriching, and I am deeply appreciative of the support and mentorship I received from you and the entire team.

During my internship, I had the privilege of working in a variety of departments that allowed me to apply the theoretical knowledge I gained in my studies to real-world situations. The hands-on experience I acquired has significantly enhanced my skills. Additionally, the constructive feedback and encouragement from you and my colleagues have been instrumental in my professional and personal growth. I particularly valued the collaborative work environment and the emphasis on innovation and continuous improvement. I have learned the importance of teamwork, effective communication, and adaptability, lessons that I will carry forward in my career.

Once again, thank you for the invaluable experience and the opportunity to be a part of your esteemed organization. I am confident that the knowledge and skills I have gained during this internship will greatly contribute to my future endeavors. I look forward to staying in touch and hope to have the opportunity to work with you again in the future.

With sincere appreciation,

Kanishka Garjola

IIHMR-Delhi

Summer Internship Report

At

Central TB Division, Ministry of Health and Family Welfare (MoH&FW)

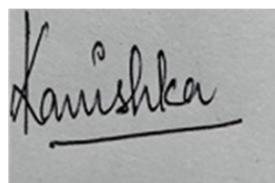(April 29TH to June 29TH, 2024)

A Report By

KANISHKA GARJOLA

(PG/23/046)

PGDM (Hospital and Health Management)

2023-2025

INTERNATIONAL INSTITUTE OF
HEALTH MANAGEMENT RESEARCH

सत्यमेव जयते

NATIONAL TUBERCULOSIS ELIMINATION PROGRAMME
TB MUKT BHARAT
TB Harega Desh Jeetega

FEEDBACKFORM

(IIHMR MENTOR)

Name of the Student: KANISHKA GARJOLA.

Summer Internship Institution: CENTRAL TB DIVISION (MINISTRY OF HEALTH)

Area of Summer Internship: Public private mix, public policy, advocacy, research [Holistic].

Attendance: 59/60 days.

Objectives met: All Objective met as per the study guidelines

Deliverables: Study report & Data analysis

Strengths: Data Analytics. In. Health programme.

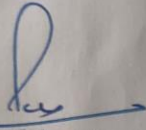Suggestions for Improvement: Advanced Excel & Data analytics.

Signature of the Officer-in-Charge (Internship)

Date: 19 Dec
Place: New Delhi.

Certificate of Approval

The Summer Internship Project of titled "**The Role of AI-Assisted Interventions in Reducing Loss to Follow-Up in India's National Tuberculosis Elimination Programme (NTEP): A Comparative Review**" at "**Central TB Division** is hereby approved as a certified study in management carried out and presented in a manner satisfactorily to warrant its acceptance as a prerequisite for the award of **Post Graduate Diploma in Health and Hospital Management** for which it has been submitted. It is understood that by this approval the undersigned do not necessarily endorse or approve any statement made, opinion expressed, or conclusion drawn therein but approve the report only for the purpose it is submitted.

Name of the Mentor
Designation
IIHMR, Delhi

FEEDBACK FORM

Name of the Student: KANISHKA GARJOLA

Summer Internship Institution: CENTRAL TB DIVISION, MoH&FW

Area of Summer Internship: no specific (holistic)

Attendance: 59/60 DAYS

Objectives met:

- Completed two research studies i.e. primary titled Determinants of Loss to Follow Up during treatment among Tuberculosis patients in various states of India and secondary comparative review named Tech vs. Tradition: A Comparative Review.
- Learnt Monitoring and Evaluation system at three levels i.e. Centre, State and District.

Deliverables:

- Observe and study each service department and the functioning of the organization
- Work on specific issue/project work assigned by the organization
- Prepare a report and share it with the organization and present it to IIHMR

Strengths: Committed & dedicated student. She is keen to learn new things & update herself on all the latest developments on the subject.

Suggestions for Improvement: Training in research tools & methodologies can help her do better.

Signature of the Officer-in-Charge:

डॉ रघुराम एस राव / Dr. Raghuram. S. Rao
सहायक महानिदेशक (टीबी) / Assistant Director General (TB)
केंद्रीय टीबी प्रभाग / Central TB Division
स्वास्थ्य और परिवार कल्याण मंत्रालय
Ministry of Health & Family Welfare
भारत सरकार / Govt. of India
जीवन विहार बिल्डिंग, नई दिल्ली-110001
Jeevan Vihar Building, New Delhi-110001

Date: 24/06/2024
Place: Central TB Division (New Delhi)

Kanishka Garjola

TABLE OF CONTENTS

S.no.	INDEX	PAGE NO.
1.	Acknowledgements	3
2.	Abbreviations	4
3.	About the Organization	5
4.	Core Purpose / Vision	5
5.	Core Ideology / Core Values	6
6.	List of Departments	7
7.	Department's Observation Findings and Recommendations	
8.	Public-Private Mix	8-12
9.	HR and Training	12-13
10.	Procurement and Supply Chain	14-16
11.	BCG revaccination	16
12.	TB and Co-morbidity	17
13.	PTB and EPTB Management	19-20
14.	Monitoring and Evaluation	21-23
15.	ACSM and Laboratory Management	24
16.	Project Report	26
17.	Annexure	31
18.	References	34

ACKNOWLEDGEMENT

ABBREVIATIONS

1.	**ADG**	Additional Director General
2.	**CTD**	Central TB Division
3.	**DST**	Drug Susceptibility Testing
4.	**EQA**	External Quality Assessment
5.	**LPAs**	Line Probe Assays
6.	**MDR-TB**	Multidrug-Resistant Tuberculosis
7.	**MoH&FW** -	Ministry of Health and Family Welfare
8.	**NTEP**	National Tuberculosis Elimination Program
9.	**NGOs**	Non-Governmental Organizations
10.	**PGDM**	Post Graduate Diploma in Management
11.	**RNTCP**	Revised National Tuberculosis Control Program
12.	**SAG**	Senior Administrative Grade
13.	**SOPs**	Standard Operating Procedures
14.	**TB**	Tuberculosis
15.	**WGS**	Whole-Genome Sequencing
16.	**PTB**	Pulmonary TB
17.	**EPTB**	Extra Pulmonary TB
18.	**ACSM**	Advocacy Communication and Social Management

CENTRAL TB DIVISION

About the Organization

The Central TB Division (CTD), a key part of India's Ministry of Health and Family Welfare, is tasked with the formidable mission of eradicating tuberculosis (TB) through the National Tuberculosis Elimination Program (NTEP), previously known as the Revised National Tuberculosis Control Program (RNTCP). Established in response to the significant TB burden, the CTD's mandate is to implement, monitor, and continuously improve TB control strategies across India. The division operates under the Directorate General of Health Services and is headed by the Deputy Director General (TB). It functions through a decentralized network of state TB cells, district TB centers, and peripheral health institutions, ensuring the reach and efficacy of its interventions. The CTD's responsibilities encompass policy formulation, program planning, and operational guidance, aiming to set national targets and allocate resources effectively. It monitors program progress through a robust surveillance system that collects and analyzes data to inform decision-making. Capacity building is another critical function, involving training healthcare workers in TB diagnosis, treatment, and management to maintain service quality. Ensuring a continuous supply of quality-assured anti-TB drugs is crucial, and the CTD oversees the entire supply chain from procurement to distribution. Advocacy, communication, and social mobilization efforts are vital for public awareness, reducing stigma, and encouraging early diagnosis and treatment. The division's research initiatives foster collaborations with national and international institutions to develop innovative TB control tools and strategies. Over the years, the CTD has achieved significant milestones, including improved case detection and treatment success rates, and reduced TB mortality. Innovations such as the GeneXpert MTB/RIF test for rapid diagnosis reflect its commitment to leveraging technology. Despite these successes, TB remains a significant public health challenge in India, necessitating continuous efforts and adaptation of strategies. The CTD's work is indispensable in the broader context of public health in India, underscoring the importance of a coordinated, well-resourced, and strategically dynamic approach to TB control and eventual elimination.

Core purpose / Vision

The core purpose of the Central TB Department is to spearhead comprehensive efforts aimed at preventing, controlling, and ultimately eradicating tuberculosis (TB) across the nation. This involves meticulous surveillance and data analysis to guide public health actions, developing and implementing national policies aligned with international standards, and executing effective prevention and control programs. The department also focuses on advancing research to improve diagnostics, treatments, and vaccines while addressing challenges such as drug-resistant TB. Enhancing healthcare professionals' capabilities through training and support, and fostering partnerships with national and international organizations, are crucial components of its strategy. The vision of the Central TB Department is to achieve a TB-free nation where everyone has access to quality healthcare for TB prevention, early detection, and effective treatment, ensuring a healthy and productive life for all. This vision includes the complete eradication of TB, universal health coverage, and the adoption of innovative solutions to improve TB care. It also emphasizes community engagement to combat stigma and support patients, the development of resilient healthcare systems, and establishing the department as a global leader in TB control, contributing to international eradication efforts and setting benchmarks for excellence.

Core Ideology / Core Values

The Central TB Department's core ideology is rooted in the commitment to public health, equity, and innovation in the fight against tuberculosis (TB). Central to this ideology is the unwavering belief that every individual, regardless of socioeconomic status, deserves access to high-quality TB care. This drives the department's dedication to developing and implementing effective TB control strategies that are inclusive and equitable. Key values guiding the department include integrity, where transparency and accountability are paramount in all operations; compassion, ensuring that patient care is centered around dignity and empathy; and excellence, striving for the highest standards in research, diagnostics, and treatment. Collaboration is also a fundamental value, as the department actively engages with global health organizations, local communities, and various stakeholders to foster a unified and robust response to TB. Innovation is encouraged to continuously improve TB control measures and embrace new technologies and methodologies. Lastly, sustainability is emphasized to build resilient healthcare systems capable of enduring public health challenges. These values collectively underpin the Central TB Department's mission to eradicate TB and enhance the overall health and well-being of the population.

List of department

Officer	To learn About
Dr. Alok Mathur Addl DDG TB (SAG)	Multi-sectoral engagement and inter-ministerial collaborations; Partnerships & Private Sector Engagement; IH (Stop TB partnership, BRICS, SAARC etc.) & Bilateral cooperation & Donor Coordination; Urban TB Initiative; HR; Training & Capacity Building; Admin related matters.
Dr. Veena Dhawan Addl. Commissioner	Procurement and supply chain management; Nikshay Aushadhi – Monitoring; Operational Research; Adult BCG vaccine; TB Preventive Treatment (TPT), TB prevention including airborne infection control; Publication of annual reports for CTD & other reports.
Dr. Sanjay Kumar Jt. Commissioner	TB-Comorbidities and management of TB & pregnancy & gender responsive approach, Paediatric TB & EPTB Management; Corporate Sector Engagement & TB Association of India; Drug Sensitive TB including adherence; Drug Resistant TB Management; Medical College involvement
Dr. Raghuram Rao Assistant Director General (TB)	PM TB MBA; Global Fund and World Bank Projects; Policy & Planning including PIP related matters; NHM related matters; Health & wellness centres; NIKSHAY (ICT application) & CTD website, Artificial Intelligence, other digital interventions & DBT; Nikshay Aushadhi – IT; Call Centre Management; Parliament related matters; Sub National Certification; TB Epidemiology; Aspirational Districts & Block Programme, Monitoring & Evaluation; Surveillance, Active Case finding.
Dr. Nishant Kumar Joint Director	Laboratory Services and Management, NTM Zoonotic TB; Community Engagement; ACSM, Tribal TB Initiatives and PM JANMAN initiative; Finance related matters including buyer for GeM.

Department's Observation, Findings and Recommendations

> **Department dealing with Push Notification of Tb:**

TB Notification in India

Background

Tuberculosis (TB) remains a major public health issue in India. The cornerstone of TB prevention and control is early diagnosis and complete treatment. The National TB Control Programme (NTP) ensures that all patients have access to quality-assured diagnostic and treatment services, including mechanisms to ensure treatment adherence. However, India has a large and rapidly growing private health sector, where substantial amounts of anti-TB drugs are sold. Non-standardized prescribing practices and unsupervised treatment regimens often lead to treatment interruptions and the development of drug resistance. The Revised National TB Control Programme (RNTCP) provides mechanisms for treatment adherence, including Directly Observed Therapy (DOT), but many patients do not benefit from these services, leading to incomplete treatments and multidrug-resistant TB (MDR-TB).

To mitigate these issues, the Government of India declared TB a notifiable disease on May 7, 2012. All public and private health providers are required to notify TB cases to public health authorities, enabling the extension of RNTCP services to these patients.

Objectives

The primary objectives of TB notification are to ensure proper diagnosis and case management, reduce TB transmission, and address the emergence and spread of drug-resistant TB. This involves obtaining complete information on all TB cases diagnosed and treated across various sectors to facilitate effective public health interventions.

Minimum Information Requirement for TB Notification

For effective TB notification, certain minimum information is required:

1. Patient details (name, age, gender, address)

2. Diagnostic details (date of diagnosis, type of TB)

3. Treatment details (start date, treatment regimen)

4. Healthcare provider details (name, contact information).

Mechanisms for TB Notification

1. Direct Notification by Healthcare Providers: Healthcare providers report TB cases directly to the local public health authority.

2. Online Notification Systems: Utilization of digital platforms to facilitate real-time notification and data collection.

3. Collaborative Notification: Coordination between different healthcare facilities and providers to ensure comprehensive reporting of TB cases.

Responsibilities

District Level Nodal Officer

1. Overseeing the TB notification process within the district.

2. Ensuring all healthcare providers are aware of their notification obligations.

3. Providing support and training to healthcare providers on TB notification procedures.

4. Monitoring and evaluating the notification data to identify gaps and areas for improvement.

Local Public Health Authority

1. Receiving TB notifications from healthcare providers.

2. Verifying and consolidating the notified data.

3. Ensuring the notified patients are linked to appropriate TB care and treatment services.

4. Reporting the consolidated data to higher authorities.

Health Worker

1. Identifying and reporting TB suspects.

2. Ensuring that diagnosed patients are registered for treatment.

3. Following up with patients to ensure treatment adherence and completion.

4. Educating patients and communities about TB and the importance of treatment adherence .

Conclusion

The guidance tool aims to streamline the TB notification process, ensuring accurate and comprehensive data collection. This facilitates better TB case management, reduces transmission, and addresses the challenge of drug-resistant TB. The collaborative effort between public and private sectors is crucial for the success of TB control programs in India.

Findings:

- It highlights several key findings essential for the effective notification and management of tuberculosis (TB) cases. The document emphasizes that TB notification is critical for early diagnosis and appropriate treatment, thereby reducing transmission and preventing complications. It outlines the importance of accurate and timely notification for monitoring and evaluating TB control programs, enabling better resource allocation and intervention planning. The notification process is essential for managing multidrug-resistant TB (MDR-TB) by ensuring adherence to standardized treatment protocols.

- The primary objectives of TB notification are to ensure comprehensive case detection, enhance patient management, and strengthen public health surveillance. Comprehensive case detection involves capturing all TB cases diagnosed and treated across both public and private healthcare sectors, ensuring a complete picture of the TB burden in the country. Enhancing patient management is achieved by linking notified patients to appropriate TB care and treatment services, ensuring adherence to treatment regimens, and preventing treatment interruptions that can lead to drug resistance.

- The document defines specific categories for TB notification to standardize the process, including new cases, previously treated cases, and drug-resistant TB cases. These definitions help in categorizing and managing TB cases more effectively, ensuring that each patient receives the appropriate level of care and monitoring.

- Various mechanisms for TB notification are outlined, including direct notification by healthcare providers, online notification systems, and collaborative notification. Direct notification requires healthcare providers, including laboratories, private practitioners, clinics, hospitals, and nursing homes, to report TB cases directly to the designated nodal officers. This process ensures that all TB cases are captured and reported promptly. The use of online notification systems, such as the Ni-Kshay portal, facilitates real-time data collection and transmission, making the notification process more efficient and accessible. The document also discusses the future integration of mobile communication methods, such as phone calls, Interactive Voice Response Systems (IVRS), and SMS, to further streamline the notification process.

- Collaborative notification involves coordination between healthcare providers and local public health authorities, particularly in regions where a bilateral understanding exists. This approach ensures that TB cases are reported accurately and promptly, even in remote and rural areas. It requires prior consultation and approval from the district nodal officer to ensure that all notifications are appropriately recorded and monitored.

- The responsibilities of various stakeholders in the TB notification process are clearly outlined. District-level nodal officers are responsible for overseeing the notification process within their districts, ensuring that all healthcare providers are aware of their notification obligations, and providing necessary support and training. They are also tasked with verifying and consolidating notification data, ensuring that notified patients are linked to appropriate TB care services, and reporting consolidated data to higher authorities.

- Local public health authorities play a crucial role in receiving TB notifications from healthcare providers, verifying the data, and ensuring that patients receive the necessary care and treatment. They are also responsible for reporting the data to district-level authorities and providing support to healthcare providers in the notification process. Health workers at the ground level are essential for identifying and reporting TB suspects, ensuring that diagnosed patients are registered for treatment, and following up with patients to ensure treatment adherence and completion. They also play a key role in educating patients and communities about TB and the importance of treatment adherence.

- The document includes various forms and formats to facilitate the TB notification process. These include the Health Establishment Registration Form, which collects details about the health establishment, such as the name, type, registration number, contact person, and contact details. The TB Notification Reporting Format is used by medical practitioners and healthcare establishments to report TB cases, capturing patient details, diagnosis information, treatment initiation dates, and other relevant data. There is also an undertaking form for healthcare providers who do not routinely diagnose or treat TB cases, allowing them to declare their non-involvement in TB case management while agreeing to notify any future TB cases they may encounter.

- The guidance tool underscores the importance of regular monitoring and evaluation of the TB notification process to identify gaps and areas for improvement. District-level nodal officers are responsible for conducting regular reviews of the notification progress within their districts and ensuring that all notified TB cases are entered into the Ni-Kshay portal within two weeks of submission. This continuous monitoring helps in maintaining the accuracy and completeness of TB notification data, which is crucial for effective TB control and prevention efforts.

- In addition to the notification mechanisms, the document emphasizes the need for effective communication and collaboration among various stakeholders involved in TB control. This includes

healthcare providers, public health authorities, non-governmental organizations (NGOs), and community health workers. By fostering a collaborative approach, the TB notification process can be more efficient and comprehensive, ensuring that all TB cases are captured and managed appropriately.

- The document also highlights the importance of training and capacity-building for healthcare providers and public health authorities. Regular training sessions and workshops are necessary to ensure that all stakeholders are well-versed in the TB notification process, understand their roles and responsibilities, and are equipped with the skills needed to effectively manage TB cases. This training is crucial for maintaining high standards of TB care and ensuring that patients receive the best possible treatment and support.

- Furthermore, the guidance tool discusses the integration of TB notification with other health information systems to streamline data collection and reporting. By leveraging existing health information infrastructure, the TB notification process can be made more efficient, reducing the burden on healthcare providers and improving the accuracy and timeliness of data. This integration also facilitates better coordination between different health programs, promoting a more holistic approach to public health management.

HR and Training:

- Human Resources (HR) and training in the central TV division in India are critical to fostering a dynamic and efficient work environment. The HR department is tasked with several key responsibilities that ensure the smooth operation and success of the organization. One of the primary functions of HR is recruitment and staffing, which involves identifying staffing needs and managing the hiring process. This includes collaborating with department heads to determine the required skill sets and qualifications for various roles, conducting interviews, evaluating candidates, and making hiring decisions. Effective recruitment ensures that the organization attracts and retains top talent, which is essential for maintaining high standards of production and creativity in the TV industry.

- Once new employees are hired, the onboarding and orientation process becomes crucial. This phase helps new hires acclimate to the company culture, understand organizational policies, and become familiar with their specific roles and responsibilities. A well-structured onboarding process not only helps new employees feel welcomed but also sets the foundation for their future success within the organization.

- Training and development are central to maintaining a skilled and knowledgeable workforce. The HR team in the central TV division is responsible for assessing training needs across various departments and developing tailored programs to address these needs. This can include workshops, seminars, on-the-job training sessions, and continuous learning opportunities that keep employees updated on the latest industry trends and technological advancements. By investing in employee development, the organization enhances its overall performance, promotes innovation, and ensures that its staff remains competitive in a rapidly evolving industry.

- Performance management is another vital area where HR plays a crucial role. Implementing effective performance appraisal systems helps set clear performance standards and provides a framework for regular evaluations. Through these evaluations, HR can offer constructive feedback and coaching, helping employees to improve their skills and achieve their career goals. Recognizing and rewarding high performers not only boosts morale but also encourages a culture of excellence and continuous improvement within the organization.

- Employee relations are also a significant aspect of HR's responsibilities. This involves addressing employee grievances, resolving conflicts, and fostering a positive work environment. Good communication and a supportive workplace culture are essential for employee satisfaction and retention. HR also plays a role in promoting work-life balance and ensuring the well-being of employees, which can include implementing policies for flexible work arrangements and providing access to health and wellness programs.

- Compliance and legal matters are another area where HR's expertise is essential. Ensuring adherence to labor laws and regulations is crucial for avoiding legal issues and maintaining a fair and equitable workplace. This includes managing employee records, maintaining confidentiality, and conducting training on workplace ethics and harassment prevention.

Recommendations:

- Department is Running Efficiently without any error.

Procurement and Supply chain

Introduction

Efficient supply chain and procurement management are critical to the success of health programs, particularly those aimed at combating communicable diseases such as tuberculosis (TB). The "Guidelines for Programmatic Management of Tuberculosis Preventive Treatment in India" provide a comprehensive framework for managing the procurement and supply chain for TB preventive treatment (TPT). This observation focuses on the procurement processes, distribution flow, inventory management, and the overall efficacy of these systems in ensuring the availability and accessibility of TPT drugs across India.

Procurement Process

The procurement of TPT drugs is centralized and managed by the Central TB Division, Ministry of Health and Family Welfare (MoHFW), Government of India (GoI). This centralized approach helps in maintaining uniformity and quality of the drugs supplied. The annual state-specific planning is crucial for forecasting the demand for various TPT regimens. This forecasting contributes to the national level quantification, ensuring that adequate quantities of drugs are procured and supplied to meet the needs of the states.

The procurement process also involves outsourcing laboratory tests and kits for TB infection (TBI) detection, materials for adherence technologies like 99DOTS/MERM, and other necessary supplies such as silica gel desiccants and educational posters. This comprehensive procurement strategy ensures that all necessary components for effective TPT are available.

Drug Distribution Flow

Once procured, the drugs are stored at the Government Medical Store Depot (GMSD) and Central Medical Services Society (CMSS) stores. The centralized storage ensures that drugs are maintained under optimal conditions before being distributed to state drug stores (SDS). The distribution to states is planned and communicated in advance to ensure that SDS can prepare adequate storage space.

From the SDS, the drugs are distributed to district drug stores (DDS) with a buffer stock of three months on a quarterly basis. The DDS then supplies the treatment units (TUs) on a monthly basis, maintaining a buffer stock of two months. Finally, TUs supply the health facilities (HFs) with a one-month buffer stock. This multi-tiered distribution system ensures that drugs are available at every level of the healthcare delivery system, minimizing the risk of stock-outs.

Inventory Management

Inventory management is a critical component of the supply chain for TPT drugs. The guidelines stipulate the use of the Ni-Kshay Aushadhi Software for tracking the receipt and distribution of drugs at the SDS level. This software aids in maintaining real-time data on drug availability, facilitating better inventory control and timely replenishment of stocks.

The guidelines also provide detailed stocking norms for various levels of the healthcare system. For example, the treatment supporter is required to maintain a full course of TPT drugs for each beneficiary. Health facility drug stores must maintain a reserve stock of two months, while district drug stores and state drug stores must keep a three-month reserve stock. These norms help in ensuring that adequate quantities of drugs are always available, thereby preventing interruptions in treatment.

Challenges and Recommendations

Despite the comprehensive framework, the supply chain and procurement processes for TPT in India face several challenges. These include delays in procurement and distribution, inadequate storage facilities at various levels, and issues with inventory management such as overstocking or stock-outs. To address these challenges, the following recommendations are proposed:

1. Strengthening the Forecasting Mechanism: Improving the accuracy of demand forecasting at the state level can help in better national level quantification and procurement. This can be achieved through enhanced data collection and analysis techniques.

2. Capacity Building: Training healthcare workers and supply chain managers on effective inventory management practices can reduce the risks of overstocking or stock-outs. Regular training programs should be conducted to keep the personnel updated on the latest practices and technologies.

3. Infrastructure Development: Upgrading storage facilities at the state, district, and health facility levels can ensure that drugs are stored under optimal conditions, reducing the risk of spoilage and wastage.

4. Technological Integration: Expanding the use of digital platforms like the Ni-kshay Aushadhi Software can improve transparency and efficiency in drug distribution and inventory management. Integrating these platforms with other healthcare information systems can provide a holistic view of the supply chain.

5. Monitoring and Evaluation: Regular monitoring and evaluation of the supply chain processes can help identify bottlenecks and areas for improvement. This should be coupled with feedback mechanisms to ensure that corrective actions are implemented promptly.

BCG Revaccination Introduction:

Introduction

As I delve into the topic of the Bacille Calmette-Guérin (BCG) vaccine, I'm reminded of its pivotal role in the fight against tuberculosis (TB). The BCG vaccine, the only one available for TB prevention, has been integral to global TB control efforts since its inception in the early 20th century. India, a country with a high TB burden, has extensively utilized the BCG vaccine in its immunization programs. This brief aims to summarize these aspects, underscoring the BCG vaccine's importance in India's TB prevention strategy.

Historical Context

The BCG vaccine was first developed by Albert Calmette and Camille Guérin in 1921. Its journey in India began in the 1940s and it was incorporated into the National Tuberculosis Program (NTP) in 1962. Reflecting on this historical timeline, it's clear that the widespread adoption of the BCG vaccine aimed to curtail TB incidence, particularly among children. Over the years, the vaccine has become a cornerstone of India's TB control strategy, significantly contributing to the decline in TB cases and mortality rates.

Efficacy of BCG Vaccine

Understanding the efficacy of the BCG vaccine requires acknowledging its variability across different regions and populations. Research indicates that the vaccine offers substantial protection against severe TB forms like TB meningitis and miliary TB in children. However, its effectiveness in preventing pulmonary TB, the most common TB form, varies. This variability is influenced by genetic factors, environmental conditions, and the presence of non-tuberculous mycobacteria. Despite these differences, I recognize the BCG vaccine as an essential tool in protecting children from severe TB in high-burden countries like India.

Implementation Strategies

India's approach to BCG vaccination is systematic and comprehensive. The vaccine is part of the Universal Immunization Program (UIP), ensuring that all new-borns receive it. The implementation involves coordination

between government bodies, healthcare providers, and international organizations like the World Health Organization (WHO). Typically, the BCG vaccine is administered at birth or as soon as possible thereafter. Additionally, special campaigns are organized to reach unvaccinated children, especially in remote and underserved areas, demonstrating a commitment to universal coverage.

Challenges in BCG Vaccination

Despite the structured approach, several challenges persist in the BCG vaccination program. One significant challenge is the variability in vaccine efficacy, complicating the assessment of its overall impact on TB control. Logistical issues, such as maintaining the cold chain, ensuring timely vaccine delivery, and reaching remote populations, pose substantial hurdles. Moreover, managing vaccine-related adverse events, although rare and generally mild, adds another layer of complexity.

TB and Co-morbidity

The comprehensive document, "Guidelines for Programmatic Management of Tuberculosis Preventive Treatment in India," sheds light on various aspects of TB management and its intersection with other health conditions. Here, I delve into the key insights and observations related to TB comorbidities.

- As I explored the guidelines, it became evident that TB is not an isolated health issue; it intertwines with numerous other diseases, exacerbating their impact and complicating treatment protocols. The document emphasizes the critical need for integrated care approaches to effectively manage TB alongside its comorbidities.
- One of the most significant comorbidities discussed in the guidelines is HIV. The immune- compromised state of individuals living with HIV makes them particularly vulnerable to TB. The document highlights the necessity of routine TB screening for people living with HIV (PLHIV) and underscores the importance of initiating antiretroviral therapy (ART) alongside TB treatment to improve patient outcomes. The synergy between HIV and TB necessitates a coordinated response to address the dual burden these diseases impose.
- Diabetes is another major comorbidity that complicates TB management. The document points out that individuals with diabetes have a threefold increased risk of developing TB. This bidirectional relationship means that TB can worsen glycemic control in diabetic patients, while diabetes can hinder the body's ability to fight TB. Thus, the guidelines recommend regular screening for diabetes in TB patients and vice versa. Managing both conditions concurrently requires careful monitoring and tailored treatment plans to ensure effective control of both diseases.

- Malnutrition is also highlighted as a critical factor influencing TB outcomes. Malnourished individuals are more susceptible to contracting TB due to their weakened immune systems. The guidelines stress the importance of nutritional support as an integral part of TB treatment. Ensuring adequate nutrition not only helps in faster recovery but also improves the overall health and resilience of TB patients.

- The document also brings attention to the co-occurrence of TB with chronic respiratory diseases. Conditions such as chronic obstructive pulmonary disease (COPD) and silicosis increase the risk of TB due to impaired lung function and damaged respiratory tissues. For individuals with such conditions, the guidelines recommend vigilant screening for TB and adopting preventive measures to mitigate the heightened risk.

- Mental health, often overlooked in the context of TB, is another crucial aspect discussed. TB and its prolonged treatment can lead to mental health issues such as depression and anxiety. Conversely, pre-existing mental health conditions can negatively impact TB treatment adherence and outcomes. The guidelines advocate for integrating mental health services into TB care programs to provide comprehensive support to patients.

- Furthermore, the document addresses the comorbidity of TB with lifestyle diseases such as cardiovascular diseases and smoking-related conditions. Smoking, in particular, is identified as a significant risk factor for TB, as it damages the respiratory system and compromises immune function. The guidelines recommend smoking cessation programs as part of TB management strategies to improve treatment efficacy and patient health.

- The guidelines also highlight the challenges posed by TB in populations with other infectious diseases, such as hepatitis. Co-infection with hepatitis B or C can complicate TB treatment due to potential drug interactions and the added burden on the liver. Managing such co-infections requires careful selection of medications and monitoring to avoid adverse effects and ensure successful treatment outcomes.

- From my perspective, understanding and addressing TB comorbidities is crucial for a holistic approach to TB management. The interplay between TB and other health conditions creates a complex web that requires integrated, patient-centred care strategies. By acknowledging and addressing these comorbidities, healthcare providers can improve the quality of care and outcomes for TB patients.

Management of Extra-pulmonary Tuberculosis (EPTB) and Pulmonary Tuberculosis (PTB)

As an active participant in the fight against tuberculosis (TB) under the Central TB Division, I am acutely aware of the diverse challenges and complexities involved in managing both Pulmonary Tuberculosis (PTB) and Extra-pulmonary Tuberculosis (EPTB). The successful management of TB, whether it affects the lungs or other parts of the body, requires a thorough understanding of its clinical presentation, diagnostic strategies, treatment protocols, and the provision of holistic care to patients.

Understanding PTB and EPTB

Pulmonary Tuberculosis (PTB) is the most common form of TB, primarily affecting the lungs. It is characterized by symptoms such as a persistent cough, chest pain, hemoptysis (coughing up blood), fever, night sweats, and weight loss. PTB is highly infectious, spreading through airborne droplets when an infected person coughs or sneezes. Due to its infectious nature, PTB poses significant public health challenges, especially in densely populated areas.

Extra-pulmonary Tuberculosis (EPTB), on the other hand, occurs when Mycobacterium tuberculosis infects organs other than the lungs. EPTB can affect various parts of the body, including the lymph nodes, pleura (lining around the lungs), bones and joints, genitourinary system, central nervous system (CNS), abdomen, and even the skin. The symptoms of EPTB vary widely depending on the organs involved, making its diagnosis more challenging compared to PTB.

Diagnostic Strategies

Pulmonary Tuberculosis (PTB):

1. Sputum Microscopy and Culture: Sputum samples are examined under a microscope for the presence of acid-fast bacilli (AFB). Culture tests, although time-consuming, provide definitive results and help in drug susceptibility testing.

2. Chest X-ray: Imaging studies such as chest X-rays are used to detect lung abnormalities indicative of TB.

3. GeneXpert MTB/RIF: This molecular test detects TB bacteria and identifies rifampicin resistance, providing results within a few hours.

4. Clinical Evaluation: Symptoms, medical history, and physical examination are crucial for diagnosing PTB.

Extra-pulmonary Tuberculosis (EPTB):

1. Site-Specific Samples: Depending on the site of infection, samples such as lymph node aspirates, pleural fluid, cerebrospinal fluid (CSF), urine, or tissue biopsies are collected for testing.

2. Imaging Studies: Imaging techniques such as ultrasound, CT scans, MRI, and X-rays help visualize TB involvement in various organs.

3. Histo-pathological Examination: Biopsy samples are examined microscopically for TB granulomas.

4. Molecular Tests: GeneXpert and other nucleic acid amplification tests (NAATs) are used to detect TB bacteria in EPTB samples.

5. Clinical Evaluation: Detailed history and examination, along with site-specific diagnostic tests, guide the diagnosis of EPTB.

Treatment Protocols

Pulmonary Tuberculosis (PTB):

1. Standard Treatment Regimen: PTB is treated using a combination of first-line anti-TB drugs, typically including isoniazid, rifampicin, ethambutol, and pyrazinamide. The intensive phase lasts two months, followed by a continuation phase of four months.

2. Drug-Resistant TB: In cases of drug-resistant TB (DR-TB), second-line drugs and longer treatment regimens are required. Drug susceptibility testing guides the selection of appropriate medications.

3. Directly Observed Treatment, Short-course (DOTS): Ensuring patient adherence to the treatment regimen through DOTS is critical to prevent relapse and drug resistance.

Extra-pulmonary Tuberculosis (EPTB):

1. Standard Treatment Regimen: Similar to PTB, EPTB is treated with first-line anti-TB drugs. However, the treatment duration may be extended to 9-12 months, especially for TB meningitis or bone and joint TB.

2. Site-Specific Considerations: The treatment approach may vary based on the site of infection. For instance, TB meningitis requires higher doses of anti-TB drugs due to the need to penetrate the blood-brain barrier.

3. Adjunctive Therapies: Corticosteroids may be used in cases of TB meningitis or pericarditis to reduce inflammation and prevent complications.

4. Surgical Intervention: In some cases of EPTB, surgical procedures may be necessary to manage abscesses, drain fluid collections, or stabilize affected bones and joints.

Conclusion

I understand that the management of PTB and EPTB requires a comprehensive, patient-centered approach. By employing robust diagnostic strategies, adhering to standardized treatment protocols, and providing continuous monitoring and support, we can effectively manage TB in all its forms. Addressing the challenges of delayed diagnosis, drug resistance, and patient adherence through a multifaceted approach is crucial for achieving successful treatment outcomes. By strengthening our healthcare systems and fostering collaboration, we can move closer to the goal of eliminating TB and improving the health and well-being of those affected by this devastating disease.

➢ Monitoring and Evaluation

The Ni-Kshay portal, developed by the Central TB Division in India, is a comprehensive online platform that revolutionizes the monitoring and management of tuberculosis (TB) cases. This digital tool enables seamless data collection, reporting, and analysis, ensuring effective supervision and control of TB across the country. The process of monitoring through the Ni-Kshay portal involves several key steps, from case notification and diagnostic information entry to treatment monitoring and adherence tracking, ultimately enhancing the efficiency and effectiveness of TB control efforts.

CASE NOTIFICATION

The monitoring process begins with the registration of TB cases on the Ni-Kshay portal. Healthcare providers, including those from both the public and private sectors, identify and register new TB patients. This registration includes detailed information such as the patient's demographics, clinical history, and diagnostic test results. Each registered patient is assigned a unique identification number, known as the Ni-Kshay ID, which serves as a reference for all subsequent monitoring activities. This unique ID ensures that patient information is accurately tracked throughout their treatment journey.

DIAGNOSTIC INFORMATION ENTRY

Following the initial case notification, detailed diagnostic information is entered into the Ni-Kshay portal. This includes results from various diagnostic tests such as sputum smear microscopy, X-rays, GeneXpert, and culture tests. By centralizing this diagnostic data, the portal facilitates timely and accurate diagnosis, which is critical for the initiation of appropriate treatment regimens. The entry of diagnostic information ensures that all TB cases are systematically documented, allowing for a comprehensive overview of the TB burden and the effectiveness of diagnostic tools in different regions.

TREATMENT INITIATION AND MONITORING

Once a TB case is confirmed through diagnostic tests, the treatment initiation phase begins. Healthcare providers use the Ni-Kshay portal to document the prescribed treatment regimen, including the type and duration of anti-TB drugs. The portal also tracks patient appointments and medication dispensation, ensuring that patients receive their medications on time. This systematic tracking helps in monitoring treatment adherence, which is crucial for preventing the development of drug-resistant TB strains.

Regular updates on patient progress and treatment outcomes are recorded in the portal, allowing for real-time monitoring and intervention if necessary.

ADHERENCE TRACKING AND SUPPORT

One of the critical components of the Ni-Kshay portal is its focus on treatment adherence. Non-adherence to TB treatment can lead to incomplete treatment, relapse, and the emergence of drug-resistant TB. To address this, the portal includes features for monitoring patient adherence to their treatment regimen. Healthcare workers can record patient visits, medication pickups, and directly observed therapy (DOT) sessions. Additionally, the portal can generate reminders and alerts for both patients and healthcare providers, ensuring that missed doses are promptly addressed. By providing a structured system for adherence tracking, the Ni-Kshay portal plays a vital role in improving treatment outcomes and reducing the incidence of drug-resistant TB.

DATA ANALYSIS AND REPORTING

The Ni-Kshay portal is equipped with robust data analysis and reporting capabilities. The data collected from various healthcare facilities are aggregated and analyzed to provide insights into TB trends, treatment outcomes, and program performance. The portal generates detailed reports that help the Central TB Division and other stakeholders in making informed decisions. These reports include information on case detection rates, treatment success rates, and the geographical distribution of TB

cases. By providing a comprehensive view of the TB situation in the country, the portal enables targeted interventions and resource allocation to areas with higher TB burdens.

SUPERVISION AND ACCOUNTABILITY

Effective supervision is crucial for the success of any TB control program. The Ni-Kshay portal enhances supervision by providing real-time data access to program managers at various levels. Supervisors can monitor the performance of healthcare facilities, track the progress of TB cases, and identify gaps in service delivery. The portal also includes features for conducting regular audits and evaluations, ensuring that healthcare providers adhere to standardized protocols and guidelines. By enhancing supervision and accountability, the Ni-Kshay portal helps in maintaining the quality of TB care and ensuring that program objectives are met.

INTEGRATION WITH OTHER HEALTH SYSTEMS

The Ni-Kshay portal is designed to integrate seamlessly with other health information systems. This integration allows for a holistic approach to healthcare delivery, where TB control activities are aligned with other public health initiatives. For instance, the portal can interface with HIV/AIDS programs, maternal and child health services, and non-communicable disease programs. This integrated approach ensures that TB patients receive comprehensive care, addressing co-morbid conditions and improving overall health outcomes. Furthermore, the integration facilitates data sharing and coordination among different health programs, enhancing the overall efficiency of the healthcare system.

FUTURE DIRECTIONS AND CHALLENGES

While the Ni-Kshay portal has significantly improved TB monitoring and management in India, there are still challenges that need to be addressed. Ensuring data quality and completeness is an ongoing concern, as accurate data is crucial for effective decision-making. Additionally, the portal needs continuous updates and enhancements to keep up with evolving healthcare needs and technological advancements. Expanding the coverage of the portal to include all healthcare providers, especially in remote and underserved areas, is also essential for achieving universal TB care. Addressing these challenges will require sustained efforts and collaboration among all stakeholders, including government agencies, healthcare providers, and the community.

➢ **ACSM and Laboratory Management According to the Central TB Division**

I was deeply involved in two crucial aspects of tuberculosis (TB) control: Advocacy, Communication, and Social Mobilization (ACSM) and laboratory management. These components are integral to our comprehensive approach to TB control, ensuring that we not only detect and treat TB cases effectively but also engage communities, improve awareness, and foster supportive environments for TB patients. In this narrative, I will elaborate on the roles and strategies of ACSM and laboratory management in our TB control efforts.

Advocacy, Communication, and Social Mobilization (ACSM)

Advocacy is the cornerstone of our TB control strategy. Central TB Division aim to influence policy, secure funding, and garner support from key stakeholders, including government bodies, non-governmental organizations (NGOs), and the private sector. Advocacy efforts focus on highlighting the burden of TB, the importance of sustained investment in TB control, and the need for integrating TB services into the broader healthcare system. By engaging with policymakers and stakeholders, we strive to ensure that TB remains a priority on the national health agenda and that sufficient resources are allocated for TB control activities.

Communication:

Effective communication is essential to raising awareness about TB, reducing stigma, and promoting early diagnosis and treatment. Our communication strategies involve disseminating accurate information about TB symptoms, transmission, prevention, and treatment through various channels, including mass media, social media, community outreach programs, and educational materials. We tailor our messages to different audiences, ensuring that they are culturally appropriate and easily understood. By empowering individuals with knowledge, we encourage timely healthcare-seeking behavior and adherence to treatment regimens, ultimately reducing TB transmission and improving patient outcomes.

Social Mobilization:

Social mobilization involves engaging communities and building partnerships to create a supportive environment for TB patients. We work closely with community leaders, health workers, volunteers, and TB survivors to mobilize support for TB control activities. Community engagement efforts include organizing awareness campaigns, health fairs, and support groups, as well as training community health

workers to identify and refer TB cases. By fostering a sense of ownership and responsibility within communities, we aim to break down barriers to TB care, such as stigma and discrimination, and ensure that TB patients receive the support they need throughout their treatment journey.

Laboratory Management

Laboratory management is a critical component of TB control, as accurate and timely diagnosis is essential for effective treatment and prevention of TB transmission. Our efforts in laboratory management encompass strengthening diagnostic capacity, ensuring quality assurance, and implementing advanced diagnostic technologies.

Strengthening Diagnostic Capacity:

To enhance our diagnostic capacity, we have established a network of laboratories across the country, ranging from peripheral laboratories to advanced reference laboratories. We have invested in infrastructure, equipment, and human resources to ensure that laboratories are equipped to perform a wide range of diagnostic tests, including sputum smear microscopy, culture, drug susceptibility testing (DST), and molecular tests such as GeneXpert MTB/RIF. By decentralizing diagnostic services and improving access to quality diagnostics, we can promptly identify TB cases and initiate appropriate treatment.

Quality Assurance:

Maintaining high standards of quality assurance is paramount to ensuring the reliability and accuracy of TB diagnostic tests. We have implemented a robust quality assurance system that includes regular training and certification of laboratory personnel, proficiency testing, and external quality assessment (EQA) programs. Our quality assurance measures also involve developing and adhering to standard operating procedures (SOPs), conducting routine equipment maintenance, and monitoring laboratory performance through supervisory visits and audits. By upholding stringent quality standards, we can confidently rely on laboratory results to guide clinical decision-making and TB management.

Advanced Diagnostic Technologies:

The integration of advanced diagnostic technologies has revolutionized TB diagnosis and management. One of the key advancements is the use of molecular diagnostic tests, such as GeneXpert MTB/RIF, which detect TB bacteria and identify rifampicin resistance within a few hours. This rapid diagnostic tool is particularly valuable for detecting multidrug-resistant TB (MDR-TB) and ensuring timely initiation of appropriate treatment. Additionally, we are exploring the use of newer technologies, such

as line probe assays (LPAs) and whole-genome sequencing (WGS), to enhance our diagnostic capabilities and support comprehensive drug resistance surveillance.

Integration with Healthcare Systems:

Effective laboratory management requires seamless integration with the broader healthcare system. We have established robust referral systems to ensure that patients with suspected TB are promptly referred to diagnostic facilities. Laboratory results are integrated into our digital health information systems, such as the Ni-Kshay portal, enabling real-time data sharing and monitoring. This integration facilitates efficient case management, treatment follow-up, and program evaluation. By linking laboratory services with clinical care, we can provide a continuum of care for TB patients and improve overall health outcomes.

Capacity Building:

Capacity building is a continuous process aimed at enhancing the skills and competencies of laboratory personnel. We conduct regular training programs and workshops to update laboratory staff on the latest diagnostic techniques, quality assurance practices, and biosafety protocols. Additionally, we provide technical support and mentorship to laboratories, helping them address challenges and improve their performance. By investing in the professional development of laboratory personnel, we ensure that our diagnostic services remain up-to-date and of high quality.

Challenges and Solutions:

Despite our efforts, we face several challenges in ACSM and laboratory management. These include limited resources, infrastructure constraints, workforce shortages, and the need for continuous quality improvement. To address these challenges, we advocate for increased funding, strengthen partnerships with stakeholders, and leverage technology to optimize our operations. For instance, the use of digital tools for training, data management, and communication has enhanced our efficiency and effectiveness in TB control.

PROJECT REPORT

Introduction

I have been passionately engaged in addressing the formidable challenge of tuberculosis (TB) in India, a country that bears a significant portion of the global TB burden. The National TB Elimination Programme (NTEP) in India plays a pivotal role in the nation's public health strategy. However, the program is frequently hindered by the issue of patients discontinuing their treatment, commonly referred to as loss to follow-up (LTFU). This challenge significantly undermines the effectiveness of the TB elimination efforts.

Driven by a commitment to find innovative solutions, I delved into the potential of integrating Artificial Intelligence (AI) with traditional approaches to foresee and mitigate LTFU. This narrative review examines the impact of AI-assisted interventions compared to conventional methods, aiming to enhance patient retention and treatment adherence within NTEP.

Review Question

The central question of my research was: How do AI-assisted interventions and traditional methods within India's National TB Elimination Programme (NTEP) impact TB control outcomes, and what do these findings reveal about the role of technological advancements in improving health outcomes?

Methods

To explore this question, I undertook a comprehensive literature search using electronic databases i.e. PubMed and Google Scholar, EMBase, Cochrane as well as reviewing relevant journals, including the Journal of Tuberculosis and Lung Disease. Keywords for the search included terms like tuberculosis, TB treatment, National TB Elimination Programme, AI-assisted interventions, conventional methods, predictive modeling, risk factors, survival analysis, and text mining. I included studies that reported on the impacts of AI-assisted interventions or conventional methods implemented within NTEP. The data sources ranged from academic articles and government reports to pilot studies and other relevant publications.

Quantitative data on LTFU rates were extracted from TB annual reports and pilot studies conducted in states like Karnataka, Uttar Pradesh, West Bengal, and Maharashtra. Additionally, qualitative data from selected studies provided insights into factors affecting TB treatment adherence and patient outcomes, such as socioeconomic status, treatment support services, adverse drug reactions, and social determinants. By

synthesizing findings from these studies, I identified common themes and patterns related to the impacts of AI-assisted interventions and conventional methods on TB control outcomes.

Conventional Methods

Effective monitoring of TB programs is crucial for ensuring successful planning and implementation. Traditional methods go beyond case detection techniques and predictive indicators; they also aim to identify patients who are at risk of becoming LTFU in the near future. Predictive modeling, risk factor assessments, survival analysis, and text mining/NLP techniques are some of the conventional approaches used to monitor and predict LTFU.

Predictive Modeling

Predictive modeling is designed to identify individuals at risk of discontinuing TB treatment, allowing healthcare providers to intervene early and prevent adverse outcomes. By analyzing patient data, predictive models can forecast potential LTFU cases, enabling timely interventions.

Predictive modeling involves the use of statistical techniques and machine learning algorithms to analyze historical patient data and identify patterns that may indicate a higher risk of LTFU. Variables such as demographic information, clinical characteristics, treatment history, and socioeconomic factors are included in the models. The models can then predict which patients are more likely to discontinue treatment and flag them for additional support and monitoring.

The success of predictive modeling relies heavily on the quality and completeness of the data used. Inaccurate or missing data can lead to incorrect predictions, potentially causing more harm than good. Therefore, robust data collection and management practices are essential for the effective use of predictive modeling in TB programs.

Risk Factor Assessments

Various factors influence LTFU in TB treatment, including individual characteristics, treatment support services, drug side effects, and social factors. Studies have shown that socioeconomic status, educational level, mental health conditions, and timely diagnosis are critical factors affecting treatment adherence. Additionally, adverse drug reactions and social determinants, such as housing instability and stigma, can pose significant barriers to treatment continuation.

Identifying these risk factors helps healthcare providers develop targeted interventions to address the specific needs of at-risk patients. For example, providing additional counseling and support to patients with mental health issues, offering transportation assistance to those with mobility challenges, or ensuring that patients understand the importance of completing their treatment regimen.

Survival Analysis

Survival analysis techniques, such as Kaplan-Meier curves and Cox proportional hazards models, are valuable tools for studying the time until LTFU occurs in TB treatment programs. These methods allow researchers to assess factors associated with early dropout from treatment and identify dynamic predictors of LTFU over time.

Survival analysis provides insights into the duration of treatment adherence among patients and highlights critical time points where the risk of LTFU is highest. This information can inform the development of targeted interventions at specific stages of the treatment process to reduce the likelihood of patients discontinuing their therapy.

Text Mining and Natural Language Processing

Text mining and NLP techniques analyze unstructured text data from clinical notes, patient interviews, or social media to extract valuable insights and linguistic cues indicative of potential LTFU behavior. These techniques augment quantitative data with qualitative information, enhancing the predictive accuracy of models.

By processing and analyzing large volumes of unstructured text data, NLP techniques can identify common themes and patterns related to patient experiences and behaviors. For example, recurring mentions of side effects, transportation issues, or social stigma in patient interviews or clinical notes can signal a higher risk of LTFU. These insights can then be used to tailor interventions to address the specific challenges faced by at-risk patients.

AI Model

The AI model used in NTEP is a machine learning tool designed to stratify TB patients prone to LTFU early, facilitating tailored interventions and care. By modifying patient monitoring workflows and operational protocols, the AI model enhances the effectiveness of identifying genuine non-adherence. This model frames the prediction of whether a patient will experience LTFU as a binary classification challenge, assigning a risk score based on patient-level characteristics.

The AI model leverages various machine learning algorithms, such as decision trees, random forests, and neural networks, to analyze patient data and predict the likelihood of LTFU. These algorithms can handle large volumes of data and identify complex patterns that may not be apparent through traditional statistical methods.

The implementation of the AI model involves several steps, including data preprocessing, feature selection, model training, and validation. Data preprocessing involves cleaning and transforming the raw data to ensure it is suitable for analysis. Feature selection identifies the most relevant variables for predicting LTFU, while model training involves using the selected features to train the machine learning algorithms. Finally, the model is validated using a separate dataset to ensure its accuracy and reliability.

The AI model's predictive capabilities allow healthcare providers to identify at-risk patients early in the treatment process, enabling timely interventions to prevent LTFU. For example, patients flagged by the AI model as high risk may receive additional support, such as more frequent follow-up visits, counseling, or social services assistance.

Results

The analysis of LTFU rates among TB patients in Karnataka, Uttar Pradesh, West Bengal, and Maharashtra within NTEP revealed promising trends following the introduction of AI-assisted interventions. For instance, Karnataka's LTFU rate decreased from 3.4% in 2019 to 2.5% in 2020. Similar improvements were observed in other states, indicating a positive impact on patient retention and treatment adherence.In Uttar Pradesh, the implementation of AI-assisted interventions led to a reduction in LTFU rates from 4.2% in 2019 to 3.1% in 2020. In West Bengal, the LTFU rate decreased from 3.8% to 2.9% over the same period. Maharashtra also saw a notable decline, with LTFU rates dropping from 4.0% to 3.0%.

These improvements highlight the potential of AI-assisted interventions to enhance TB treatment adherence and reduce LTFU rates. The data suggests that AI models can accurately identify at-risk patients and enable healthcare providers to implement timely and effective interventions.

However, it is important to note that the success of AI-assisted interventions depends on several factors, including the quality of data, the effectiveness of the algorithms used, and the capacity of healthcare providers to implement and sustain the interventions. Continuous monitoring and evaluation are essential to ensure the ongoing effectiveness of AI-assisted interventions and to address any emerging challenges.

Conclusion

Integrating AI-assisted interventions with conventional methods within NTEP holds significant promise for reducing LTFU and improving TB treatment outcomes. Despite challenges such as scalability and equitable access, the positive impact observed in key states underscores the potential of AI to transform TB control efforts.

Continued research and efforts to overcome implementation barriers are crucial for maximizing the benefits of AI technologies in TB control across diverse regions of India.

The integration of AI into TB control programs represents a significant advancement in public health. By leveraging the power of machine learning and predictive analytics, healthcare providers can better identify and support patients at risk of LTFU, ultimately improving treatment adherence and reducing the burden of TB.

While the initial results are promising, it is essential to address the challenges and limitations associated with AI-assisted interventions. These include ensuring data quality and completeness, addressing potential biases in the algorithms, and providing adequate training and resources for healthcare providers to effectively implement and sustain the interventions.

Furthermore, it is important to consider the ethical implications of using AI in healthcare, particularly in terms of patient privacy and data security. Robust measures must be in place to protect patient data and ensure that AI models are used in a transparent and accountable manner.

In conclusion, the integration of AI-assisted interventions with conventional methods within NTEP offers a promising approach to reducing LTFU and improving TB treatment outcomes in India. By addressing the challenges and limitations associated with AI implementation and ensuring ongoing monitoring and evaluation, we can maximize the benefits

ANNEXURE

Ni-Kshay Portal for TB Monitoring

Advocacy Material by Central TB Division

REFERENCES:

- World Health Organization (WHO). (2021). Global Tuberculosis Report 2021. Geneva: WHO.

- Central TB Division. (2022). National Tuberculosis Elimination Program (NTEP) Annual Report 2022. Ministry of Health and Family Welfare, Government of India.

- Ministry of Health and Family Welfare. (2023). Revised National Tuberculosis Control Program (RNTCP) Guidelines. Government of India.

- Sharma, S. K., & Mohan, A. (2019). Tuberculosis: From Basic Science to Patient Care. Indian Journal of Medical Research, 150(5), 451-470.

- National Institute for Research in Tuberculosis (NIRT). (2022). TB India 2022: Annual Status Report. Chennai: NIRT.

- Pai, M., & Kasaeva, T. (2018). TB Control in India: Innovative Approaches for a Century-Old Disease. The Lancet, 391(10130), 1506-1518.

- Dhingra, V. K., & Rajpal, S. (2020). Public-Private Mix in Tuberculosis Control: Experience and Perspectives. International Journal of Tuberculosis and Lung Disease, 24(11), 1138-1145.

- Indian Council of Medical Research (ICMR). (2021). Tuberculosis Research and Development in India: An Overview. New Delhi: ICMR.

- Sachdeva, K. S., & Chauhan, L. S. (2020). Implementation of GeneXpert MTB/RIF in National TB Programmes: Early Results and Challenges. Journal of Clinical Tuberculosis and Other Mycobacterial Diseases, 19, 100150.

- Kumar, A., & Goel, N. (2022). Role of Artificial Intelligence in Predicting TB Treatment Outcomes. Journal of Global Health, 12, 04038.