





Closing the Gaps in the TB Care Cascade (CGC) Project

A Process Document on improving TB diagnosis services through iSmart Intervention

(iSmart- Artificial Intelligence & Smart X-ray Report)

Acknowledgement

Closing the TB care cascade (CGC) project gaps is supported through a USAID Co-operative Agreement no. 72038620CA00012.

Disclaimer:

The publication of the document is made possible by the support of the American People through the United States Agency for International Development (USAID). The contents of the document are the sole responsibility of WHP and do not necessarily reflect the views of USAID or the United States Government.

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Acronyms and Abbreviations

AI	Artificial Intelligence
BMP	Bitmap Image
CAD	Computer-Aided Detection
СС	Care Coordinators
CGC	Closing the Gap in TB Care Cascade
CME	Continuing Medical Education
CXR	Chest X-ray
DBT	Direct Benefit Transfer
DICOM	Digital Imaging and Communications in Medicine
DMC	Designated Microscopy Centre
DRTB	Drug-Resistant Tuberculosis
DSTB	Drug Sensitive Tuberculosis
DTO	District TB Officer
GHS	General Health Care Staff
НСР	Health Care Providers
HSC	Health System Coordinator
IMA	Indian Medical Association
JPEG	Joint Photographic Expert Group
NPY	Ni-kshay Poshan Yojana
NTEP	National Tuberculosis Elimination Program
OOPE	Out of Pocket expenditure
PHI	Peripheral Health Institution
STS	Senior TB Supervisor
ТВ	Tuberculosis
TU	TB Unit
UHC	Universal Health Coverage
WHP	World Health Partners

About the CGC project

Closing the Gaps in TB Care Cascade (CGC) is a four-year project (2020-2024) funded by the United States Agency for International Development (USAID) and led by World Health Partners (WHP). The project is being implemented in partnership with consortium members: the Indian Institute of Public Health-Gandhinagar (IIPHG), Everwell Health Solutions, and Harvard Medical Schools (HMS). It operates in four districts—Ranchi and East Singhbhum (Jharkhand), as well as Surat and Gandhinagar (Gujarat).

The TB care cascade visualizes various stages of gaps in care delivery. To effectively address these gaps, the project has designed an implementation and monitoring framework related to the TB care cascade and is demonstrating intervention models. Critical gaps identified include patients' loss due to inability to access TB diagnostic tests, obtaining an accurate diagnosis, access to TB treatment, adherence to daily medication, and maintaining a TB-free status post-treatment. The project also focuses on cascades for TB sub-populations with DR-TB, comorbidities, and other high risks.

Project Geographies:



Geographic Coverage of Interventions under CGC Project

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Summary of th	Summary of the TB units and peripheral health institutions under CGC project, India						
State	District	Population	TU	PHI/DMC			
Jharkhand	East Singhbhum	0.6 million	10	19			
	Ranchi	1.5 million	15	28			
Gujarat	Gandhinagar	0.3 million	5	51			
	Surat	4.4 million	27	144			
	Total	57	242				
iSMART	Intervention (Projed	39*	1295 (HCP and				
			Radiological				
				Unit)			

*Due to a lack of radiological units (CXR Facilities) several TUs were not covered under the iSMART intervention.

Table 1 Summary of Populations and PHI Coverage under CGC Project

1. Background

- India bears the highest burden of Tuberculosis (TB) and Multidrug-resistant (MDR) TB, as per the estimates in the Global TB Report 2021. Although recent data indicates a decline in TB prevalence, the absolute number of new cases remains high. India has set a target to achieve the End TB Goals by 2025 through robust implementation of the National Tuberculosis Elimination Program (NTEP) interventions^{1,2}.
- There continues to be a significant global gap between the estimated number of incident cases (9.9 million, range 8.9–10.9 million in 2020), with 4.1 million cases remaining undetected due to underreporting, underdiagnosis, or lack of access to healthcare for people with TB³. In 2021, India reported a total of 2.1 million TB cases, comprising 1.4 million notifications from the public sector and 0.7 million from the private sector. These reported TB cases accounted for 71% of the targeted 2.9 million cases, indicating that 29% of cases went undiagnosed or were missed in 2021⁴. Beyond the disease itself, social determinants also contribute significantly to the onset of TB and its adverse outcomes⁵.

	Microbiological Te	sts	Supportive Tests
Diagnosis of TB	Smear Microscopy ZN FM NAAT Culture Solid Liquid		Chest X-Ray TST IGRA Cytology - FNAC Histopathology – Biopsy Radiologyetc
		Molecular Tests	Growth based Tests
Drug Susco	eptibility Test	NAAT LPA	Culture Solid Liquid

Figure 1 Tools for TB diagnosis among presumptive TB patients

 Most TB patients seek treatment at healthcare facilities to alleviate their symptoms, making it critical to suspect tuberculosis in these symptomatic cases and subject them to sputum examination.

¹ GLOBAL TUBERCULOSIS REPORT 2021 [Internet]. 2021. Available from: <u>http://apps.who.int/bookorders</u>.

² WHO. WHO consolidated guidelines on tuberculosis. Module 4: treatment - drug-resistant tuberculosis treatment. Online annexes. WHO. 2020.

³ Chakaya J, Khan M, Ntoumi F, Aklillu E, Fatima R, Mwaba P, et al. Global Tuberculosis Report 2020 – Reflections on the Global TB burden, treatment and prevention efforts. International Journal of Infectious Diseases. 2021

⁴ Ministry of Health and Family Welfare Government of India Coming Together to End TB Altogether [Internet]. Available from: http://www.tbcindia.gov.in

⁵ Bhargava A, Bhargava M, Juneja A. Social determinants of tuberculosis: context, framework, and the way forward to ending TB in India. Vol. 15, Expert Review of Respiratory Medicine. 2021.

 The most significant gap in the TB care cascade lies within the diagnostic pathway, where patients often face difficulties accessing a TB test and obtaining a reliable diagnosis. Consulting multiple healthcare providers consistently leads to diagnostic delays. Artificial Intelligence (AI)-assisted diagnostic tools hold the potential to reduce these gaps by influencing provider behavior. However, previous AI-assisted tools have primarily focused on accuracy, lacking a comprehensive understanding of the uptake and utilization of these tools in an operational setting. World Health Partners (WHP) has identified an innovative solution: an automated AI chest X-ray reading tool capable of detecting multiple abnormalities, including TB. This tool enables healthcare providers to swiftly reach a probable diagnosis.

2. Rationale of the Intervention

2.1 Diagnostic Gaps in the TB Care Cascade:

- The non-engagement of all types of providers in TB care can potentially limit the success of the National Tuberculosis Elimination Program. The inability to integrate all healthcare providers formal and informal in private sectors (HCPs) during the diagnostic care cascade highlights a missed opportunity to achieve estimates of notification.
- Substantial research studies indicate that formal and informal healthcare providers are the first point of contact for a considerable proportion of TB patients. However, our understanding of their role in TB prevention, diagnosis, and treatment is limited beyond that point. Studies on the role of HCPs in TB care have discovered that they raise community awareness, assist in diagnosing symptomatic cases, and collect sputum.
- One of the most critical factors in diagnostic delay has been identified as seeking initial care from HCPs (especially AYUSH providers, chemists, quacks, etc.). Involving HCPs can promote earlier detection of TB, an important component of WHO's TB control and elimination strategy⁶.

2.2 Chest X-Ray in the Diagnostic Care Cascade:

- The chest X-ray (CXR) is used as a screening tool to improve the sensitivity of the diagnostic algorithm. Any abnormality in the chest radiograph is further investigated for tuberculosis, including microbiological confirmation.
- In the absence of microbiological confirmation, an X-ray can be used as supporting evidence in the diagnosis. It can also diagnose extrapulmonary TB, such as pleural effusion, pericardial effusion, mediastinal adenopathy, and miliary TB. Although inter and intraobserver variability in X-rays is high, no X-ray shadow is specific for TB, and 10-15% of culture-positive cases may remain undiagnosed when X-ray alone is used as a diagnostic tool.

⁶ Thapa P, Jayasuriya R, Hall JJ, Beek K, Mukherjee P, Gudi N, et al. Role of informal healthcare providers in tuberculosis care in low- and middle-income countries: A systematic scoping review. Plos One [Internet]. 2021;16(9):e0256795. Available from: http://dx.doi.org/10.1371/journal.pone.0256795

- CXR is an essential tool for tuberculosis triage, screening, and diagnosis. When used correctly and effectively, CXR closes gaps in the diagnostic care cascade and aids in the early detection and initiation of TB treatment. CXR contributed to 45% of diagnosing TB patients in Jharkhand and Gujarat and 35% in India.
 - Public facilities lean more toward microscopic examination for diagnosing TB, while private facilities lean toward clinical parameters and CXR.

2.3 Findings from the Baseline Assessment:

- Further, as per the baseline assessment conducted during Jan-Feb 2021 and May-Jul 2021 for Jharkhand and Gujarat, an average delay of 23.2 days (Median 2 days (0-11) for Jharkhand and 6.1 days (Median 1 day (1-4)) for Gujarat was observed from the first consultation to TB diagnosis. Delay was observed due to various factors like lack of patient awareness regarding the importance of TB diagnosis, self-denial for providing sputum samples, stigma related to being a TB patient, limited access to diagnostic facilities in remote areas (especially in Surat rural), migration (transfer-out), and knowledge gaps on TB diagnostic algorithms in the private sector, etc⁷.
- The most significant gap in the TB care cascade was in the diagnostic pathway, whereby patients could not access a TB test and receive a TB diagnosis. Seeking initial care from healthcare providers (chemists/quacks/AYUSH) and consulting multiple healthcare providers are consistently associated with diagnostic delay. During the baseline, it was observed that the private sector relies more on CXR to diagnose pulmonary TB. Similarly, the public sector radiological units (CXR facilities) have operational issues regarding accessibility and limited capacity for reading CXR.
- According to a systematic review, most healthcare providers (HCPs) have been assigned the role of detection and diagnosis, treatment and support, and prevention. In 90% of the studies focused on detection and diagnosis, HCPs passively identified patients who visited them at their practice and referred them to a nearby health facility if their symptoms resembled tuberculosis. None of the HCPs (AYUSH, chemist, quacks) initiated TB treatment in patients, and all HCPs were involved as DOT providers for treatment and support functions⁶.

2.4 iSMART Intervention under the CGC Project:

 To address the diagnostic gaps and explore the role of HCPs in the TB Care Cascade, the iSmart intervention was implemented in 2021 as part of the CGC project. Free CXR services are provided to presumptive TB patients through HCPs, and the learnings were captured to scale up the project by involving AI in diagnosing TB in 2022. The current year investigates the operational workflow and feasibility of AI-assisted detection in closing gaps in the diagnostic care cascade for tuberculosis patients.

2.5 Project/Intervention Plan:

The project was designed to be implemented in two stages:

⁷ Baseline Assessment Report of Jharkhand and Gujarat State under the CGC Project. March 2021.

- Phase 1: Free X-ray provision for presumptive TB cases: During phase 1, healthcare providers (HCPs) and radiological units (CXR Facilities) were mapped and engaged. An application was developed to record patient details and generate a voucher ID. Once registered, presumptive tuberculosis patients are given a voucher with an ID number, providing them free CXRs from radiological units. CXR images and their reports are captured in the web application against voucher IDs.
- Phase 2: Phase 1 + Al integration: In phase 2, DeepTek's Al-assisted reading of CXR images
 was introduced to assist radiologists with probable interpretations. At remote locations
 without a radiologist, X-ray technicians upload CXR images into the application to receive
 reports from DeepTek radiologists. The intervention aimed to provide approximately 28,000
 CXRs, with 60% (16,800) utilized in Gujarat and 40% (11,200) in Jharkhand.

3. Objectives - Process documentation of Private Sector Engagement & iSMART intervention

- To describe the entire demonstration process of the Private Sector Engagement & iSMART intervention, and document the role of the call center in assessing the careseeking behavior of patients availing free CXR services under the iSMART intervention.
- To explain the lessons learned and challenges encountered during the demonstration of the intervention.
- To explain the value or role of AI in the clinical decision-making of healthcare providers.

4. Process of the documentation applied for iSMART intervention

The following processes were adopted:



- Literature Review: Various scientific papers and reports related to tuberculosis, the diagnostic care cascade, and efforts to reduce delays in this cascade were reviewed to support this document. Inferences were drawn from these sources and documented while implementing and recording the iSmart intervention.
- **Consultation with Key Stakeholders:** The process documentation involved an interactive consultation process with various stakeholders, including state officials, the World Health Partners implementation team, the radiological unit (CXR facility), pulmonologists, field workers, and healthcare providers.

The objectives were:

A. Understanding the learnings and challenges in adopting free CXR under the iSmart intervention (Phase 1).

B. Capturing the patient pathway across intervention activities.

C. Understanding the intervention framework and implementation modalities.

 Field Visits for Implementation Observation: Regular field visits were conducted for observation and participation to update the intervention process and assess challenges encountered during implementation. The feasibility of integrating the intervention with the existing system framework was investigated through consultations with state officials, district officials, and healthcare facility staff.

5. Detailed Activities across each intervention phase

The implementation began at the end of April 2021. Radiological units (CXR facilities) provided free CXR services to engaged healthcare providers (HCPs) in the first phase. The second phase involved providing AI-assisted CXR readings to the same radiological units (CXR facilities) engaged during the initial implementation. To facilitate early TB diagnosis, CGC offered free AI-assisted CXR services to private and public sector providers. The present intervention encompasses the following activities:

A. Mapping & Engagement of Healthcare Providers

- A critical component of the intervention involves selecting healthcare providers and radiological units (CXR facilities). Proper mapping and engagement establish a definitive structure for the diagnostic cascade.
- Thematic Leads trained HSCs/CCs on the mapping/engagement section of the "Commcare" application in April 2021. Care coordinators mapped healthcare providers based on geographical and potential support factors for the intervention. Contact information, qualifications, OPD load, referral linkages, etc., were captured and entered into the Commcare application to generate a unique ID for each provider.
- Various methods were employed to identify healthcare providers:
 - a) Notified patients (first-year TB patients) were queried about healthcare providers they visited during treatment.
 - b) Allopathic providers were interviewed for nearby AYUSH providers/Chemists/quacks who frequently refer cases to them.
 - c) Government officials and partner organizations at the community level served as sources for identifying healthcare provider networks.
 - d) All chemists were considered a type of healthcare provider.
 - e) All radiology units with CXR facilities, digital and manual, both public and private, were mapped. They also provided additional information on private healthcare providers.
 - f) Public PHIs in remote areas were engaged in the intervention to provide free CXR services with DeepTek's support. The interpretation of CXR images uploaded on DeepTek was shared with the facilities due to a prolonged vacancy of a radiologist position at PHIs.
- Providers with MBBS or higher qualifications, AYUSH providers, RMPs (Registered Medical Practitioners), chemists, quacks, and PHIs were mapped and engaged based on predefined criteria.

- a) For the mapping of HCPs, a Commcare application with specific checklists/forms was used. Healthcare providers were briefed on the intervention's goals and processes. HCPs were engaged upon signing the "membership form" (Attached in Annexure). A kit comprising a project and activity brief brochure, membership form, printed free CXR coupons, and project staff contact information was provided to every engaged provider.
- b) Each mapped provider received a unique ID, and engaged providers were given login credentials to access the web application for patient registration and generating voucher IDs upon uploading patient-related data as required.
- c) Engaged HCPs were also granted the facility to enroll patients through the call center service. Healthcare providers leaving a missed call at 8010111213 would receive an immediate call from the call center executive, providing all necessary information about the presumptive TB case. This information was entered into the application to generate the voucher ID, which was communicated to the healthcare provider over the phone.
- In April 2021, the intervention began by piloting in one block from each district: Ranchi Kanke, Purbi Singhbhum - Jugsali, Gandhinagar - Dahegam, and Mansa. The pilot blocks included mapping and engaging healthcare providers. It was planned to pilot the activities for 10-15 days before rolling them out across the district, considering initial learnings.
- The Covid-19 pandemic disrupted mapping and engagement activities during the initial intervention period. Due to the delay caused by the pandemic and the limited number of service providers agreeing to participate in the pilot block, it was decided to expand the activity to all four intervention districts in the CGC project.
- CME of HCPs (AYUSH, Chemist, Quacks):

Jharkhand:

- a) CME on "Sensitization and training on early detection of tuberculosis" was held in Ranchi and East Singhbhum districts on May 9th and 25th, 2022.
- b) The CME was attended by 115 people, including AYUSH, chemists, quacks, and NTEP staff.
- c) It aimed to improve presumptive case referral and unlock informant incentives for HCPs.
- d) Various topics were covered, including the role of HCPs in identifying and referring TB patients, TB and COVID-19, available referral facilities at Public PHIs, etc.
- e) Civil Surgeon at East Singhbhum and DTO in Ranchi announced unlocking an informant incentive of Rs. 500 for individuals referred first for any diagnosis (HCPs who refer for CXR) upon identifying each TB patient.

Gujarat:

- a) A CME was organized in Gandhinagar on March 26th, 2022, to enhance engagement with AYUSH providers and improve presumptive case referral.
- b) The event included a detailed discussion on the role of Chest X-rays in TB diagnosis, NTEP updates, the role of AYUSH providers, etc.
- c) Nearly 70 participants attended the event, including AYUSH doctors and NTEP staff.

Sr. No	State	Mapped	Engaged	%
1	Gujarat	1,022	753	73.7
2	Jharkhand	649	453	69.8
	Total	1,671	1,206	72.2

Table 2 Healthcare providers' mapping and engagement till July 15th, 2022

B. Mapping & engagement of CXR facilities

Mapping and engagement of CXR facilities remain crucial for providing free CXR services to Presumptive TB cases.

- Thematic leads and HSCs/CCs mapped radiology units (CXR facilities) using the Commcare application, considering factors such as geographical location, referral linkages, OPD caseload, software/hardware requirements, and more. These units were evaluated using a checklist to determine their potential for engagement. Selected CXR facilities were oriented about the intervention processes, and an MoU was signed with a few of them for engagement. Engaged CXR facilities qualified for financial reimbursement based on disparate geographical rates.
- In April 2021, HSCs/CCs received training and orientation on mapping radiology units through the "Commcare" application.
- Various methods were employed to identify CXR facilities:
 - a) Interviews with allopathic/healthcare providers to locate nearby radiological units for frequent case referrals.
 - b) Engagement with government officials and partner organizations at the community level to identify accessible radiological units.
 - c) Mapping of all radiology units with CXR facilities, digital or manual, public or private, that met the minimum requirements for AI integration.
- Radiologists were briefed on the project's intervention and expected outcomes. Thematic leads provided orientation to HSCs/CCs on voucher generation and image/report uploads using an application in June 2021. Radiologists were instructed on how to upload CXR images and reports through the web application. Additionally, radiological units were trained to generate the voucher ID from the application via the call centre (8010111213) in case a patient was referred without an ID number by a healthcare provider.
- To provide free CXR services, radiological units were reimbursed at an agreed-upon rate. These units generated invoices fortnightly, collected by care coordinators along with physical CXR vouchers. The bills were then submitted to the state office for verification and validation, contingent upon the uploaded CXR images and reports. Once verified, the bills were sent to headquarters for payment, directly deposited into the respective radiological units' accounts.

Sr. No	State	Mapped	Engaged	%	Remarks
1	Gujarat	87	45*	51.7	Average per CXR cost range between Rs. 275-450
2	Jharkhand	129	44**	34.1	Average per CXR cost range between Rs. 250-500
	Total	216	89	41.2	

Table 3 Radiological units (CXR facilities) mapping and engagement till July 15th, 2022

*Out of 45, 30 CXR facilities are private, while 15 CXR facilities belong to the public sector where radiologist's reports are availed through DeepTek.

**Out of 44, 40 CXR facilities are private, while 4 CXR facilities belong to the public sector where radiologist's reports are availed through DeepTek.

C. Process of Application Development:

- Experience and learning from other interventions guided the development and utilization of digital technology. An open data collection toolkit application named "Commcare" has been used to digitize data and information.
- Mapping of CXR facilities and Healthcare Providers: A mobile application is used to map facilities, collecting information on demographic details, education and qualifications, radiologist availability, monthly CXR volumes, CXR details (including film and report quality, file types, costs, etc.), OPD caseload, TB diagnosis and treatment procedures, referral linkages, liaison with other facilities, Ni-kshay credentials, smartphone availability, and GPS locations. After collection, filling out, and submission of information, a unique ID is generated for each mapped provider.
- In addition to Commcare, WHP has developed a web application under the intervention. The app comprises the following sections:



• This web application primarily serves three user types with specific access:



- Healthcare Providers (HCPs) and radiological units can utilize the web application to generate voucher IDs and upload CXR image files and reports. HCPs input patient demographic details like name, address, contact information, and symptoms to generate a voucher ID. They can select "X-ray Chest Free" from diagnostic tests for TB patients to access the free CXR service via the iSmart intervention. Upon entering this data, the voucher ID is generated.
- Providers can view the diagnostic statuses/results of all enrolled patients and a list of engaged radiological units (CXR facilities).

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Figure 4 Commcare application screenshot/Patient detail

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Figure 3 Commcare application screenshot/Registration

Figure 5 Commcare application screenshot/Diagnosis

D. Patient Workflow

- Presumptive TB Identification to TB Confirmation:
- a) Healthcare providers screen patients exhibiting clinical TB symptoms, labeling them as presumptive TB patients. Free CXR services are provided to these patients via unique voucher ID generation facilitated by a web application. With the voucher provided, patients are referred to the nearest engaged radiological units (CXR facilities).



- b) CXR Services: After performing free CXR, the facility provides patients with standard CXR reports and films. The facility uploads the report and CXR image to the respective voucher ID. If a patient lacks a voucher ID during a radiological unit visit, the unit registers the patient and generates the voucher ID via the call center before the CXR. The physical CXR voucher is retained for reimbursement along with the invoice. The patient receives the CXR film and report and returns to their healthcare providers for further consultation.
- c) HCPs may order additional lab tests to confirm the diagnosis based on CXR reports and patient symptoms.
- d) Presumptive TB patients identified through CXR suggestive of TB are referred for further evaluation to allopathic doctors or the government system. The WHP field team follows up on cases with "Abnormal" CXR interpretations for microbiological confirmation and MO consultation.
- e) The project staff enters relevant details of those confirmed TB cases as notified by the Government system in the Commcare application. The confirmed TB cases are regularly followed up by the CCs under various interventions under CGC that includes differentiated care, End Treatment Evaluation and Pulmonary Rehabilitation, Mental Health and Substance Abuse and TB Treatment Adherence Management Intervention.
- On June 10th, 2021, healthcare providers in Jharkhand initiated the first referral to a radiological unit (CXR facility) in Kanke block of Ranchi district. On June 14th, 2021, a similar

referral occurred in Jugsalai block of East Singhbhum district. Subsequently, on July 3rd, 2021, Healthcare Providers in Gujarat made the first referral to a radiological unit (CXR facility) in Gandhinagar (Rural) TU of Gandhinagar district, followed by another referral on July 5th, 2021, in Kamrej TU of Surat district.

- In Jharkhand, out of 7,834 referred patients, 91% underwent CXR. Among these, 32% were suggestive of tuberculosis until July 15th, 2022. Out of 2,303 suggestive cases, 39% were diagnosed with TB. These patients were duly notified in Ni-kshay and commenced treatment.
- In Gujarat, out of 12,966 referred patients, 91% underwent CXR. Among these, 36% showed signs suggestive of tuberculosis until July 15th, 2022. Following further diagnosis/consultation, 25% were diagnosed with TB, notified, and initiated on treatment out of the 4,266 suggestive TB cases.

Sr. N o	States	Patients Referred	CXR done	Suggestive TB cases against CXR done	Positive case out of presumptive	Notified cases against positive cases found
1	Gujarat	12,966	11,789 (90.9%)	4,266 (36.2%)	1,066 (25.0%)	1,066 (100.0%)
2	Jharkha nd	7,834	7,172 (91.5%)	2,303 (32.1%)	908 (39.4%)	908 (100.0%)
	Total	20,800	18,961 (91.2%)	6,569 (34.6%)	1,974 (30.1%)	1,974 (100.0%)

Table 4 Status of Patient Follow up under iSMART Intervention

E. Engagement of an agency for AI-assisted reading of CXR:

- Initially, discussions were underway with Qure.AI to employ AI solutions. Eventually, DeepTek was chosen to provide AI solutions.
- DeepTek was found to offer comprehensive and holistic solutions compatible with the available intervention infrastructure. The DeepTek platform accepts DICOM or JPEG formats of CXR images for interpretation, while Qure.AI supports only .dcm images, creating difficulties for some CXR facilities to comply.
- DeepTek solutions diagnose 21 total lung conditions, whereas Qure.AI focuses solely on TBrelated lung conditions. Additionally, DeepTek readily offers the services of a radiologist for further support if necessary.

F. Process to Understand and Employ AI-assisted Reading for Chest X-rays:

- Several computer-aided detection (CAD) software solutions have been developed to potentially assist radiologists in clinical workflows, akin to the support provided by radiological unit staff.
- CAD software generates a continuous abnormality score for TB screening, indicating the likelihood of abnormality associated with TB in a CXR image. These scores can then be categorized above a certain level, classifying the CXR image as abnormal, prompting referral for additional TB testing, such as a sputum-based molecular diagnostic test. A well-trained AI

algorithm can achieve performance levels comparable to those of a radiologist in identifying findings in TB CXR films.

- DeepTek has developed an easy-to-use web-based application that assists qualified healthcare imaging professionals in securely uploading clinical information, complying with PHI transmission standards, thereby streamlining workflow.
 - a. According to DeepTek, it collaborated with the Clinton Health Access Initiative (CHAI) and the Chennai City Corporation under the STOP TB initiative, obtaining 44,626 digital chest X-ray images in DICOM format to test the accuracy of DxTB (DeepTek's system for Alassisted screening of digital CXR for signs of TB).
 - b. DxTB detects TB in a patient with 92% accuracy, 0.91 sensitivity, and 0.92 specificity, achieving an AUROC (Area Under the Receiver Operating Characteristics) of 0.96. It has also demonstrated an 86% increase in productivity and a 46% decrease in reporting turnaround time by supporting radiologists during normal business hours⁸.
- Users can download and share imaging reports in PDF or Word format. The platform also enables tracking of case reporting status and facilitates rapid communication with concerned healthcare providers.



Process for interpreting CXR images using AI through DeepTek:

- a. Login: Radiologists/Radiological Unit must log in to the web-based application using their user ID and password.
- b. Search: Search the voucher ID number written on the voucher and click "Get" to see patients' details.

⁸ DeepTek - Learning for the CAD.

- c. **Upload Image/Report:** Click on the patient's name to upload the CXR image (JPG or DICOM format) and the report (based on the radiologist's findings) of the presumptive TB patient on the web-based application.
- d. **Findings:** After uploading the CXR image and report, select the CXR interpretation Normal/Abnormal. While uploading the CXR image and report, one can also note specific points/findings/interpretations/details related to the patient in the web-based application.
- e. Al Interpretation: After uploading a CXR image and report, the Al Interpretation option appears along with a "Copy Link" tab. The "Copy Link" tab is used to send the link to other health professionals/radiologists so they can interpret the CXR image. Clicking on Al interpretation will take about 40 seconds to display Al results on the DeepTek page.
- f. **Result of AI Interpretation:** DeepTek displays suggestive findings based on AI interpretation of the CXR image.
- g. Add Other Abnormalities: A radiologist can also add other morbid conditions (differential diagnosis) related to lung abnormalities in the report. Besides morbid conditions, radiologists can specify anatomical sites and other unusual findings specific to the condition in the results.
- h. Regenerate: When adding details to the report, the



- "Regenerate" button must be clicked to reflect changes in the report.
- i. **Edit:** If a radiologist discovers any additional points or findings, they can edit the report and click the "Regenerate" button to update it.
- j. **Save, Submit, and Download:** After the final addition, save and submit the report. On submission, there's an option to download the report file in .docx or .pdf format. Radiologists can print a copy of this report—with or without the CXR image—on letterhead and provide it to the patient or treating physician.
- k. **Remote Access:** If a radiologist is inaccessible or unavailable, staff at the radiological unit can copy the link (after uploading the CXR image) from the web-based application and share it with the radiologist to obtain a real-time report. The radiologist interprets the image and shares observations based on the CXR image before saving and submitting the findings. When a radiologist submits findings, the radiological unit staff has the option to download the report. They can print the report on letterhead and give it to the patient along with the CXR film.
- I. **Public Health Institution:** In cases of PHI without a radiologist, patients are registered by the PHI itself to generate a voucher ID.
 - The CXR is performed for the patient, and the image is uploaded into the application against the generated voucher ID.
 - When an image is uploaded, DeepTek's radiologist interprets the findings and provides a signed copy of the report.
 - The option is available with the PHI to download the report and share it with the patient.

- m. **Private Health Institution:** In remote areas of Jharkhand, private health institutions without radiologists have used DeepTek to detect tuberculosis in CXR images.
 - When the patient arrives with the voucher ID created by the healthcare providers, the technician at the radiological unit uploads the CXR image against the patient's ID.
 - The technician uploads the CXR image against the patient's ID in the absence of a Voucher ID by contacting the NTEP



Staff or Care Coordinator (WHP) to create the Voucher ID for suspected TB cases.

- Within 30 minutes of the image being uploaded, DeepTek's radiologist interprets the results and provides the facility with a signed copy of the report. Along with the CXR film, the technician prints the report and gives it to the patient.
- The patient contacts the healthcare provider to discuss the next steps in managing their health condition.

Following a tuberculosis (TB) diagnosis, the healthcare provider refers the patient to the nearest Public Health Institution (PHI) for further management of TB cases. State-specific developments are outlined below:

- Jharkhand's Rollout of AI-assisted CXR Services:
- a) In March 2022, Ranchi enrolled four remote radiological units (Jharkhand X-Ray Center, Vikas Nursing Home, The Biochemist Lab Services, and New Astha X-Ray) under DeepTek. These units capture and upload CXR images for AI-assisted reading, which are then sent to DeepTek radiologists for interpretation.
- b) AI reading for CXR images was implemented at the public health institution (SDH Gatshila) of East Singhbhum District in Jharkhand State on March 23rd, 2022. This implementation aided in the early identification of tuberculosis cases and supported medical officers in initiating early treatment in remote areas where radiologist positions had been vacant for many years.
- c) As of July 15th, 2022, a total of 23 private and 4 public facilities in Jharkhand are engaged in obtaining AI-assisted reading of CXR.
- Gujarat's Rollout of AI-assisted CXR Services:
- a) In February 2022, Gujarat enrolled 2 radiological units from Gandhinagar Corporation (Sattva Imaging Centre and Happy Imaging Centre) and one from

Gandhinagar Rural (Bansidhar Imaging Centre - Mansa) to comprehend initial challenges during the implementation of AI-reading for CXR images.

- b) The public health facility, Sadra CHC in Gandhinagar, was selected for interventions in May 2022.
- c) By July 15th, 2022, a total of 13 private facilities have been granted access and training for AI-assisted reading of CXR, and 15 CHCs/SDHs have been engaged to obtain radiologists' reports in Gujarat.

Sr.No	State	State Total	Private facility	Public health institution (DeepTek's Radiologist)
1	Jharkhand	27	23	4
2	Gujarat	27	13	15
	Total	54	36	19

Table 5 Engagement of radiological unit for Ai-assisted CXR

- A meeting was convened on May 21st, 2022, with USAID to review the progress achieved through the iSmart intervention and gain deeper insights into the diverse modalities of Chest X-rays conducted at various levels across different states.
 - a. During the meeting, it was proposed to delve into various facets of the iSmart intervention and assess its viability for expansion into remote areas.
 - b. Additionally, a suggestion was made to compare existing data with Ni-kshay data to identify any disparities in observed delays post-intervention implementation.
 - c. The expansion of AI-assisted CXR interpretation was recommended, particularly in regions lacking radiologists. An analysis comparing the sensitivity and specificity of AI (DeepTek) readings to radiologist findings, based on available CXR images within the system, was proposed.
- Moreover, an issue regarding the clarity of AI (DeepTek) generated reports specifically, whether they indicated normal or abnormal results—was resolved in July 2022. Consequently, the AI (DeepTek) reports now distinctly indicate normal and abnormal findings.

G. Establishment of a Call Centre to Assess the Care Seeking Behavior of Patients

- **Call Centre:** In October 2021, a call center was established at the WHP Head Office and the Gujarat WHP Office to monitor the services received by referred patients and to assess the care-seeking behavior of patients availing themselves of free CXR services.
- **Call Centre Executives:** Four executives were assigned to the call center and underwent comprehensive orientation on the iSMART intervention, along with training to gather patient information. They were hired based on their language proficiency, with two fluent in Gujarati and two in Hindi.
- **Data Recording:** The data of beneficiaries under the iSMART intervention is shared with the executives on a weekly basis.

- a. The executives make regular calls and input patient information (refer to Annexure 8) into the designated Google form for survey results.
- b. Patients who do not respond to calls are attempted four more times, and a list of these patients is shared with the states and CCs for further follow-up.
- **Monitoring:** All calls are recorded, cross-checked, and randomly monitored by the head office to gain insights into the approach for collecting patient information.
 - a. A weekly executive call with the head office is scheduled to discuss survey issues and provide feedback on patient-provided information.
- **Reporting:** Questionnaire responses are compiled weekly and shared with the headquarters, and on a monthly basis with the states and CCs.
- Monitored Parameters: A cohort of self-reported TB patients is compared with the combined cohort of non-TB diagnosed and self-reported TB patients for the following parameters:
 - a. Socio-demographic details
 - b. Number of providers consulted by the patient
 - c. Delays observed from the first onset of symptoms to the final diagnosis

H. iSMART PowerBi Dashboard

- iSMART PowerBi Dashboard: To monitor real-time progress and receive regular updates on the intervention, the WHP team created a dashboard displaying real-time updates on various indicators. The iSMART PowerBi dashboard incorporates 22 metrics, including information on cases registered under the intervention, provider activities, delays under iSMART intervention, and provider-wise reports.
- Metrics: These cover information on various parameters for both states (Gujarat and Jharkhand), such as cases registered, free CXR services utilized by beneficiaries, CXR results with normal and abnormal findings, identified TB cases, the number of active providers and labs, and delays registered from voucher generation to TB diagnosis.



Figure 7 Dashboard for the iSmart Intervention

6. Preliminary Results

The intervention was divided into phases in which activities were carried out, and a strategic protocol was developed based on the findings. It begins with the mapping of HCPs and ends with complete TB patient follow-up. Patients enrolled in the intervention received assistance from a variety of stakeholders.

The data of the intervention is presented in two sets of activities as below:

A. Intervention Indicators set for process activities



Figure 8 Summary of Mapping and Engagement Status of Healthcare Service Provider (up to July 15th, 2022)

 The above graph shows the engagement against mapping for the radiological units (CXR facilities) and healthcare providers. The data shows that the availability of the radiological units (CXR facilities) and healthcare providers was significant in both states, but their engagement is limited.

B. Follow-up status of patients after CXR

- Service Delivery of Free Chest X- Ray:
 - a. The graph below shows a gap of 9% in each Jharkhand and Gujarat among patients referred for CXR and CXR done till July 15th, 2022. The percentage of confirmed TB cases (against total CXR done) was approximately 13% and 9% in Jharkhand and Gujarat states respectively. The best part of the intervention in both states is that all confirmed TB cases have been notified and are put on treatment. Also, the data shows a significant number of presumptive cases with other illnesses that need to be addressed or have scope for other strategies.



Figure 2 Status of TB Patients under iSmart Intervention

C. Survey of Beneficiaries and Providers:

During the second phase of intervention, the WHP team conducted a survey to better understand the responses of beneficiaries and providers. The following are the survey results:

- Survey of the beneficiaries:
 - a. To monitor the services provided to the beneficiaries and identify gaps in treatment-seeking behavior based on socio-demographic profiles, a total of 19,907 calls were made to 12,878 unique beneficiaries from November 2021 to July 2022.
 61% (7,845) of beneficiaries responded to the calls, with 77% (6,070) providing complete information.
 - b. 57% (3,466) of the beneficiaries belong to rural settings, with around 63% (3,808) falling under the BPL category. 36% (2,161) of beneficiaries have completed high/senior secondary school.
 - c. Out of the total 6,070 respondents, 1,021 beneficiaries reported TB symptoms with a median delay of 18 days (Mean 39.0 days) from symptom onset to diagnosis. Those from rural areas (Median - 19 days & Mean - 39.4 days) and females (Median - 19 days & Mean - 43.2 days) are more likely to delay seeking healthcare compared to urban settings (Median - 16.5 days & Mean - 38.3 days) and males (Median - 18 days & Mean - 37.1 days).
 - d. Females (54%) are more likely than males (46%) to consult 3 or more providers upon TB symptom onset.
- Survey of Healthcare Providers (AYUSH, Chemist & Quacks):
 - a. A survey of healthcare providers was conducted in both project states during May-June 2022 to understand reasons for low referral rates and improve patient referral to receive free CXR.

b. A total of 973 unique providers were contacted via phone. Among them, 58% (563) responded with complete details. Main reasons for low referral were low OPD (44%, n=250), training requirements (44%, n=249), distant radiological unit (CXR Facility) (5%, n=32), internet connectivity issues (2%, n=14), and lack of interest in referring (2%, n=14).

• Survey on AI utilization by radiologists at CXR facilities:

Eighteen radiologists were surveyed on existing workflows and perceptions of AI, prior to AI exposure or use. Findings include:

- a. Radiologists have a high self-perception of competency in reading CXRs.
- Responses show positive inclinations towards AI's potential to assist clinical decision-making, but there's lower confidence in AI reliability among radiologists.
- c. Positive responses suggest AI's potential to assist workflows; however, it's not seen as a replacement for radiologists.
- d. Mixed responses indicate varying willingness among radiologists to use AI.

7. Challenges (Learnings) observed during the implementation of the pilot intervention

• Mapping and Engagement

- a. Care coordinators reported that owners of healthcare facilities were sometimes unavailable during the engagement process, preventing the CCs from capturing the critical information required for mapping/engagement. To address this issue, a follow-up section was added to the Commcare application.
- b. Some healthcare providers in Jharkhand requested financial assistance for referring patients for CXR. These facilities have been disengaged from the intervention.
- c. During an intervention, only a few centers had the DICOM (Digital Imaging and Communications in Medicine, an image file type) facility and active internet connectivity. Radiologists in Gujarat and Jharkhand have raised concerns about the hardware/software capacity to update DICOM images of CXR and report. Given the constraints, the option to upload an image in JPG format through the application was investigated.
- d. Due to a nationwide increase in COVID-19 cases, a restriction on field movement was imposed during lockdown (from April end to mid-June 2021). Care Coordinators were not receiving responses or support from providers because all health providers chose to avoid meeting with anyone other than patients while considering COVID-19 preventive measures.
- e. Initially, the intervention team had to overcome a few obstacles such as reluctance from some of the AYUSH providers in providing information at the time of mapping and engagement due to government policy. The concerns were as follows:

Need for the signing of a membership form

- Expression of interest in engagement but unwillingness to do voucher-related work as it might require extra time
- Lack of proficiency in digital technology for some
- Concerns related to HR, training, and time were expressed.

- f. Continuous efforts were made to address these issues through in-person meetings, continuing medical education, feasible assistance in voucher generation activity, regular follow-up and support, and advocacy from the local association of Healthcare providers (AYUSH).
- g. In Jharkhand, the radiological unit (CXR facility) was not linked to a radiologist, and the practice of generating reports was lacking in a few diagnostic facilities, despite having a digital radiological unit (CXR facility). It had an impact on the initial engagement process. During mapping, it was discovered that 52% of radiological units (CXR facilities) did not have a radiologist on-site at all times. There are no radiological units (CXR facilities) for a referral at the Itki, Tamar, and Bero blocks of the Ranchi district in Jharkhand. The reasons are the lack of digital radiological units (CXR facilities), and if they are available, they are not linked to any radiologist to generate the required clinical protocol report.
- h. In Gujarat, despite several follow-ups, some of the radiological units (CXR facilities) still have concerns about workload, required software/hardware updates, the additional burden of uploading images and reports. At the same time, few healthcare providers are not ready to engage due to the unwillingness to sign the membership form, the cumbersome voucher generation process, and heavy OPD. Prefilled vouchers or stamps for each healthcare provider/radiological unit (CXR facility) may be made available to minimize administrative issues.
- i. A few radiological units (CXR facilities) in Gujarat raised a concern about the selection between "Suggestive of TB" and "Non-suggestive of TB" in web applications for some CXR presentations, such as changes of Old Koch's. Radiologists, in such cases, did not select any option. It was then suggested to select the "Normal"/ "Abnormal" option and then "Suggestive of TB"/ "Non-suggestive of TB" to be chosen if the "abnormal" option is selected first. The changes were incorporated around mid-October '21.
- j. As per the implementation protocol, it was decided to engage the HCPs in phase 1 to avail free CXR services and to provide them with the facility of AI-assisted CXR services in phase 2. But with the implementation glitches and gaps, the protocol was not followed up, and HCPs were not provided with the AI-assisted CXR reading under the iSMART intervention.

B. Patient Workflow:

- In Gujarat, numerous healthcare providers requested prefilled vouchers containing the provider's name, ID, referral radiological unit (CXR facility) name and address, and other details to streamline processes, considering the high volume of OPD. Some patients were seen choosing their preferred radiological unit (CXR facility). Conversely, a few patients encountered difficulty locating the referred radiological unit (CXR facility) when its address was solely written on the vouchers.
- As a solution, it was decided to create a stamp for each radiological unit (CXR facility) containing its precise and detailed address, to be imprinted or printed on every voucher available to healthcare providers. With the inclusion of exact addresses, patients were able to locate the radiological unit (CXR facility) more easily.
- In Gujarat, certain healthcare providers do not refer patients to the engaged radiological unit (CXR facility) due to their affiliations with other units. To address this, preferred radiological units (CXR facilities) were mapped and engaged, aligning with the preferences of healthcare providers linked to those radiological units (CXR facilities).

- One challenge observed with care coordinators is the significant amount of time spent on activities like voucher generation, assisting with image uploading, and collecting/submitting vouchers for payment. This reduces their time to engage with other facilities/HCPs and troubleshoot issues with the application and AI components.
 - Radiologists tend to share/upload the CXR report and images on the web application with significant delays, which in turn delays the follow-up for patients with "Abnormal" CXR findings by field staff.
 - During visits to HCPs, it was noted that patients who brought only a CXR film (without a report) posed difficulties in TB diagnosis, as the CXR could suggest other medical conditions.
 - Newly practicing HCPs encounter challenges in interpreting abnormal medical conditions from CXR films and their differential diagnosis. They require a report that assists in interpreting the patient's clinical condition.
 - Within a year of implementation, 9% of referred patients did not reach the engaged CXR facility to avail free CXR services. WHP has followed up on such cases to understand the reasons behind this drop-out. It was observed that 34% of these patients didn't avail X-ray services, 35% were untraceable, while 31% did avail the X-ray services.
 - Beneficiaries' perception of free CXR services sometimes hampers their uptake:
 - a. When a CXR is recommended, many patients avoid it due to unawareness of the severity of their TB disease or other socioeconomic circumstances, choosing other institutions. Providing the CXR report for free from radiological units had a negative impact on patients. They questioned the value of correct findings if the CXR was available free of charge.
 - b. Patients from distant communities, e.g., 25-30 kilometers away from the radiological unit, find it challenging to reach the facility due to transportation issues and dire economic situations.
 - Waiting for the collection of CXR films and reports:
 - a. Patients must wait until the DeepTek radiologist uploads the report to the web application. Even after uploading, technicians remain unaware of the status, resulting in extended stays for patients at the facility, leading to poor referrals for subsequent visits.
 - Lack of care-seeking behavior leads to loss of follow-up of beneficiaries:
 - a. Patients with poor outcomes are more likely to be lost during follow-up visits due to a lack of care-seeking behavior and an inability to comprehend the health consequences of tuberculosis.

C. Challenges in Ai-assisted reading of CXR

During the implementation of the Ai-assisted CXR reading, there were three levels of challenges observed by the project team.

	Phase		Challenges Observed
a)	Implementation	a.	Initial Uptake and capacity building of staff for AI based CXR readings at CXR facilities

	b. с.	Infrastructure & Logistics (Computers, Internet, System, DICOM to JPEG) issues at public and private health facilities Administrative approval delays to use of AI assisted CXR for PHIs.
b) Interpretation	a. b. c.	Discrepancy in the AI interpretation and those of Radiologists Editing Report on AI platform found to be time-consuming by radiologists than they do it conventionally AI's limitation in differentiating characteristics of Old Vs Active Koch's.

• Implementation Challenges

- a. Initial Uptake and Capacity building of the Radiological Units for Ai-assisted CXR System
 - During the implementation phase of the Ai-assisted reading intervention in Jharkhand, the project staff faced challenges in imparting orientation of the AI platform; it was more challenging in tribal and hard-to-reach areas. where it was difficult to troubleshoot the AI platform-related issues.
 - During an Al implementation phase in Jharkhand, it was discovered at one of the CXR facilities that the X-ray technician was not technologically savvy, and she initially had difficulty capturing images and uploading them to the portal. She was given some initial assistance to help her overcome the problem.
 - It was observed that uploading of CXR images to the iSmart application is not realtime so there isn't any scope for Radiologists to avail and overlook AI findings before printing the CXR report and delivering the same to patients.
- b. Infrastructure & Logistics (software, Internet, hardware, DICOM to JPEG) issues in some of the public and private health facilities
 - Early implementation challenges e.g., integration-related issues observed in the integration of AI platform with iSmart application.
 - During the initial phase, it was observed that uploaded images (.dcm/ .jpg) were not read by AI software. This may be considered an integration-level challenge which eventually got resolved.
 - Public Health Institutions:
 - i. One of the key issues in the public sector is the scarcity of X-ray services in some of the TUs.
 - ii. In Jharkhand public sector facilities, it was found that technicians who are unfamiliar with technologies are hesitant to incorporate AI applications into their gadgets.
 - iii. It is observed that printed CXR report availed by DeepTek is not given to patients of public PHIs as there isn't any facility to do so at the X-ray room.
- c. Administrative approval delays for the use of AI-assisted CXR for public PHI
 - When implementing the Ai-assisted reading of CXR at public PHIs in March 2022, radiological units in Jharkhand need a letter from the Civil Surgeon. This has



- Interpretation
- a. Discrepancy in the findings of the AI and Radiologists
 - The quality of CXR images, specifically .jpg images captured through smartphones, influences AI interpretation.
 - It is observed in both the States that AI interpretation and that of radiologist has near similar findings in approximately 50% of the cases.
- b. Report editing through the AI platform
 - Radiologists are of the view that editing reports to the interpretations of AI to finalize it through the AI platform, is time taking procedure than the way they do conventionally. Thus, they don't find DeepTek AI platform convenient to be used during high OPD hours.
- c. Al's limitation in differentiating characteristics of Old Vs Active Koch's

8. Patient Enrolment in the NTEP

- The NTEP is yet to actively involve the informal sector (AYUSH, Chemists, quacks etc.) for the
 presumptive case referrals and TB case notification. During the implementation, the CGC field
 staff follows the patient throughout the diagnostic care cascade. The future scale-up of this
 intervention needs continuous involvement of all health care providers, from presumptive TB
 case identification, referral until notification into the Ni-kshay.
- The general health system staff have reached into the field through ASHA / Sahiya; they should be emphasized to capture the presumptive TB cases and follow up with them till the microbiological or clinical confirmation of TB.
- The patients were sent for further consultation with an allopathic doctor and microbiological confirmation of TB after having an abnormal CXR report. If the patient is found to have confirmed TB cases, the government system notifies into Ni-kshay with support from the intervention team. The delay may be varied from patient to patient who takes time for their clinical evaluation.

9. Stakeholders' Perspectives and Case Studies

- Jharkhand:
 - a. The response of the notified TB patient was encouraging; he was pleased with the free CXR service, which provided a report within one day and initiated treatment within two days. However, he raised concerns about transportation costs.
 - b. The interviewed healthcare provider actively participated in the intervention, regularly following up with TB patients. She highlighted the issue of transportation costs for patients referred to the radiological unit (CXR facility). Many patients were reluctant to use the free CXR services due to transportation costs, preferring government facilities despite the Rs.

70 charge per CXR. Despite her efforts to encourage patients to utilize the free CXR service provided by the iSmart intervention, comprehension and usage remained challenging. She proposed conducting camps in hotspot areas for better dissemination and communication.

c. The radiological unit (CXR facility) supports the intervention but requests more referrals for sustained involvement. They suggested offering incentives to healthcare providers in exchange for referrals to make them feel rewarded.

• Gujarat:

- a. Patients interviewed expressed satisfaction with the free CXR services and indicated a willingness to refer relatives and friends to avail themselves of these services under the intervention.
- b. Healthcare providers shared concerns about entering patient details into the application, fearing potential connections with COVID-19 reporting.
- c. An AYUSH Practitioner suggested organizing a meeting/CME (Continuing Medical Education) with AYUSH doctors and emphasized inviting their influential president to engage a larger number of HCPs under the intervention.
- d. Interviewed radiological units (CXR facilities) recommended prefilled free CXR vouchers with the referring healthcare provider's name and ID. Many healthcare providers omitted this information, causing difficulties for the radiological unit to establish connections when necessary.
- e. Some radiological units faced software limitations, being unable to connect to the internet required for CXR image uploading. They used pen drives to fetch and upload images through a computer with internet access.
- f. The care coordinator expressed concern about monitoring, citing instances where patients didn't show up for the CXR after registration. Access to the web application enables them to track all patients registered by healthcare providers and engaged radiological units. It helps generate a list of patients who haven't utilized their Voucher ID for free CXR services.

This concern was addressed by providing login credentials to each CC to operate the iSmart application.

• USAID Representatives:

The Deputy Mission Director of USAID-India acknowledged the efforts in combating TB in the community. She appreciated the field-level interventions carried out under the CGC project and was excited to learn about the challenges and lessons contributing to the interventions and their outcomes.



Case Studies:

a. Case Study of Beneficiary:

Patient 1: I have contacted my nearest HCP after a constant 21 days of coughing and moderate fever. The HCP has encouraged me to undergo a CXR since my symptoms were suggestive of TB. He handed me a coupon with which I went to the indicated CXR facility. The radiologist shared a film of Xray along with the report. HCP advise me to visit Tamar TU for further investigations. The health staff at the TU suggested a sputum examination and has begun therapy for TB based on the CXR result. Since Tamar TU doesn't have a CXR facility I would have been paid Rs. 250 to 300 to obtain CXR from a radiological unit or I was meant to visit Ranchi, a 50 km distance from my location. The service has assisted me to commence my treatment on time and saved my life. This has helped me to seek healthcare services from my local spot rather than travelling at distance or to headquarters.



b. Case Study of HCP:

HCP 1: I've been serving the community for ten years and have referred a considerable number of presumptive patients to public health facilities for CXR investigations. However, owing to a great distance, many patients are hesitant to receive CXR and are more concerned about losing their daily wages. They usually avoid visiting me for another follow-up. After joining the project, I used to refer such patients to a nearby radiological unit, and the patients began visiting me with CXR films and reports. Thus, the report and CXR film assist me in identifying serious patients in need of treatment and referring them to the public PHI to receive regular and timely treatment. I also share the patient's information with the CC so that they can track the patient and notify them under Ni-kshay for them to receive proper treatment. Thus, this intervention has assisted me in increasing my daily OPD and in making appropriate decisions for the management of TB patients.



Address - Poly Clinic, near J.K International School, Agru

c. Case Study of Radiologist:

Radiologist 1: I've been exposed to two situations when its implementation framework has impressed me. One patient, XYZ, was suffering from a serious TB complication and had previously experienced two episodes of pulmonary TB. The patient was from a local slum and was indigent. When he first visited us, he was astonished by the free services we had set up and repeatedly inquired about their affordability. Despite taking the medications earlier, he defaulted. I informed the care coordinators that this patient needed to begin treatment right away. Two days after the patient started receiving treatment, the care coordinator called me to let me know that they had taken the patient to a local government hospital and initiated treatment. The best lesson from that event was that the poorest patient was given a free Xray at our setup, and the project's follow-up system made sure the patient received a continuum of care. I believe that without these resources, he would not have chosen CXR and would not have started treatment at the appropriate time. - Radiologist, Gandhinagar Corporation, Gandhinagar, Gujarat.

10. Positive Enablers

- Reduction in TAT and Reporting:
 - a. Facilities using DeepTek witnessed a significant decrease in report turnaround time, indirectly reducing diagnostic care cascade delays.
 - b. Al-assisted intervention proved invaluable in evaluating CXR films/images at public health facilities without available radiologists.
- Private Sector Engagement:
 - a. The intervention encouraged private sector healthcare providers to participate in identifying and treating tuberculosis patients at the community level, strengthening the health system under the NTEP program.
- Notification of TB Patient:
 - a. The intervention identified 10% of TB patients among presumptive cases undergoing CXR, aiding in early TB management and community spread control.
 - b. Offering free CXR reduced patients' out-of-pocket expenses, promoting TB diagnosis and treatment-seeking behaviors.

11. Discussion and Recommendations

The intervention has been piloted in a small geographical area of the country, and more information can be gathered once it is scaled up to a larger area. During the current implementation, modifications to activities were undertaken based on the learnings received from the field. There are certain areas where strategic planning and implementation of the protocol will significantly contribute to the diagnostic phase of the TB care cascade.

• Engagement of Private Sector:

a. The intervention involves all healthcare providers in diagnosing presumptive TB patients and providing them with CXR services free of cost. The intervention adds value in minimizing the diagnostic costs for TB patients and supports the NTEP, where the system has limited capacity for radiological support.

b. The engagement of the private sector is quite challenging for all the states, and efforts have been concentrated mainly on allopathic/formal healthcare providers. The learnings from this intervention provided a scope for engaging healthcare providers, especially AYUSH, Chemists, and Quacks, etc.

c. If the linkages between NTEP and healthcare providers can be established through NTEP staff, front-line workers, or CHOs, the system can minimize the delay in the pre-diagnostic phase of the TB care cascade. In that case, presumptive patients should be enrolled in Ni-kshay to ensure follow-up until their notification.

Linkage between Presumptive TB Patient and diagnostic services (CXR):

a. The continuous follow-up of TB patients until their notification and support to healthcare providers in managing their presumptive TB patients creates a continuum of care. The assessment of the intervention and non-intervention groups may be explored to identify the potential assistance that reduces the diagnostic delay. The support structure for scaling up in a vast geography can be incorporated into the NTEP National PPP guideline.

b. The comprehensive assessment in coordination with NTEP should be explored where the intervention has limited engagement of healthcare providers and radiological units (CXR facilities) against mapped facilities and the profile of presumptive TB patients suggestive or not suggestive of TB. Continuous medical education of healthcare providers may enhance their knowledge in screening TB patients and public health actions for confirmed TB patients.

c. The presumptive cases found after free CXR may be linked with two possible options:

Cases with CXR suggestive of TB could be monitored and followed up through NTEP or health staff until their notification.

The remaining suspected cases can be followed up by the health and wellness center team for further diagnosis and treatment to ensure these patients are not left out with other illnesses.

• Transition from Traditional to Technology-Based Tracking:

a. Web and mobile applications for healthcare providers and radiological units (CXR facilities) and care coordinators may better track registered patients. The list of presumptive TB patients identified by healthcare providers can be shared with TU staff weekly.

b. Expansion of Ni-kshay with access to healthcare providers and radiological units with sensitization may enhance presumptive TB patient enrollment and tracking using tasklist generation as per guidelines.

• Artificial Intelligence-based reading of CXR:

a. Al-assisted reading of CXR images has a long way to go before it can be used to diagnose tuberculosis. The results need more structured validation and implementation at a larger scale.

b. It has the potential to significantly address diagnostic delays. However, careful planning and sustained follow-up with stakeholders will be necessary for successful implementation. A study to assess the cost-effectiveness of the intervention in addressing diagnostic delays can assist NTEP in assessing the potential for scaling up the program. There is also scope for public health facilities to upgrade themselves to adopt AI-assisted CXR services.

c. Interpretation of CXR by a radiologist from DeepTek upon uploading the CXR images has delivered excellent results in remote places where radiologists are not available, especially in the case of Jharkhand. This reduces the time required to interpret CXR images and deliver reports based on the findings. Thus, treatment of tuberculosis cases has begun on time, reducing delays in the pre-diagnostic and diagnostic care cascade from the system side, and out-of-pocket expenses from the patient's side are reduced as well.

d. This recommends exploring the possibilities of using AI-assisted radiological solutions and teleconsultation with radiologists in remote areas of the country and in the public sector where Radiologists are unavailable.

12.Way Forward

- Integrating AI-assisted CXR tools with Ni-kshay Workflow As a proposed progression, the subsequent workflows will be integrated into Ni-kshay:
 - a. Initiation within Ni-kshay:
 - The initial test will be registered on Ni-kshay.
 - Test request details, patient information, and the Digital X-Ray file will be initially updated within Ni-kshay, then subsequently transmitted to the DeepTek AI external system.
 - This integration proves beneficial in cases where the facility possesses the infrastructure to capture, store, and transfer digital X-Rays to Ni-kshay.



Initiation on the DeepTek AI System:

- a. The initial test will be conducted using the DeepTek AI external system.
- b. Patient details, test specifics, and digital X-ray samples will be generated within the DeepTek AI external system.
- c. Subsequently, these details will be transmitted to Ni-kshay via API Integration, ensuring availability within Ni-kshay as well.
- d. Particularly beneficial during mobile screening drives conducted by NTEP/NTEP Partners.



• DeepTek AI Requirements: Ni-kshay Specific Integrations

The following Ni-kshay-specific changes will be considered:

- a. DeepTek AI will be made compatible with Ni-kshay's patient and test entities. It will understand, replicate, and generate data in a format recognized by Ni-kshay.
- b. The DeepTek AI system will comprehend Ni-kshay's hierarchy and authentication, integrating accordingly:
 - Minimizing additional effort by enabling Ni-kshay SSO credentials to function within its system.
 - Creating equivalent structures that represent Ni-kshay PHIs for the creation and reception of tests.

13. Annexures

Annexure-1

 Mapping of Healthcare Providers (AYUSH, Chemist, Quacks)

 1. Name of Facility:

 2. Name of Health Provider:

 3. Mobile No. 1,

 4. District, Taluka, TU:

 5. Address:

 6. Landmark:

 7. If compounder present? (Yes/ No):

 8. Type (drop-down)

 o Chemist:

 o Chemist:

 10. Qualification (Degree): (BAMS/ BHMS/ BUMS/ DAMS/ DHMS/ MD in Homeopathy/ MD in Ayurveda/ M. Pharma/ B. Pharma/ Post Graduation/ Graduation/ Intermediate/ Matric/ Under Matric/ Others:

- 11. Years of experience overall:
- 12. Estimated number of patients seen/ day (overall):
- 13. Estimated number of presumptive TB patients seen per month:
- 14. How does the health provider typically treat presumptive TB patient?
- Diagnostic services offered (if any) [X-ray, Sputum microscopy, CBNAAT, Blood Tests, CT scan, other] - Multiple options may be selected
- o Treatment options if any [Antibiotics, AKT, refer to formal provider, refer to Government]
- 15. Number of Referral allopathic providers/ public facility (if any) (If referring to more than one provider option to collect details for more number of providers)
 - Name (if public facility name of institution)
 - o Address
 - Public/ Private
 - Contact number (if available)
- 16. Number of Referral CXR labs (if any) (If referring to more than one lab option for collect details for more number of labs)
 - o Name
 - o Address
 - Public/Private
 - Contact number (if available)
 - Digital x-ray / manual x-ray
- 17. Does this health provider work at another facility?
- 18. How many ____
- 19. Details of other facilities

 - Address: _____
- 20. Owns a Smartphone? (yes/no): ______
- 21. Has Credentials in Ni-kshay? (yes/no)
 - o If yes, ID: _
- 22. Targeted (yes/no)
- 23. Engaged (yes/no)
- 24. Status
 - o Open
 - Shut down
 - Relocated
- 25. GPS location: _____

Mapping of CXR Facilities

- 1. Name of facility: _____
- 2. Name of point of contact:
- 3. Address: ______
- 4. Landmark:
- 5. Mobile number #1: ______ Mobile number#2_____
- 6. Public or private?_____
- 7. Digital CXR? (yes/no):
- 8. Radiologist available (yes/No) (if the facility has any tie up with radiologist collect that details too)
- 9. If yes: Qualification (MD Radiology/ DMRD/ other)
- 10. Radiographer available (yes/ no): ______
- 11. Days/Hours of operation: _____
- 12. Volume of CXRs per month (overall): _____
- 13. Cost of CXR (INR): ______
 - 1. Manual: ______
 - 2. Digital:
- 14. Data fields captured in CXR report (drop-down): _____
- 15. Picture of a sample CXR report that is provided to patient (if feasible): _____
- 16. Availability of internet/ broadband connection: _____
- 17. File type of Digital X-ray: DICOM/ Nifti/ Minc/ Unknown______
- 18. Referral provider (s)/ facilities (Names): ______
- 19. Owns a smartphone? (yes/no): ______

- 22. GPS:

Mapping of Healthcare Providers (Allopathy, PHI)

- 1. Name of facility: _
- 2. Number of Providers (Below data fields triggered for each provider): _____
- 3. Name of provider: ______
- 4. Address: ______
- 5. Landmark:
- 6. Mobile number #1:______Mobile number #2:_____
- Qualification (MD- Internal Medicine/MD-Pulmonologist/ DTCD/ID physician/MBBS/other)
 1. ______ (Please write if other)
- 8. Days/Hours of operation: _____
- 9. Estimated number of patients seen/ day (overall): ______
- 10. Estimated number of cough/fever seen per month: ______
- 11. Estimated number of diagnosed TB cases per month: _____
- 12. Has a HFID? (If yes, enter HFID): ____
- 13. Notifies TB cases to Ni-kshay? (himself/herself or through Hub agent/Or handing over to Govt. on monthly basis)
- 14. Does this provider have any tie up with any lab for x-ray?
 - 1. If yes, name of the x-ray facility: _
- 15. Does this provider work at another facility?
 - 1. If yes, details of other facilities: ______
 - 2. Name of Facility: _____
 - 3. Address:
- 16. Targeted (yes/no): _____
- 17. Willing to engage? (yes/no): _____
- 18. Engaged (yes/no): ______
- 19. Status
 - 1. Open
 - 2. Shut down
 - 3. Relocated

20. GPS: _____

Memorandum of Understanding

Date		
То		

Dear Sir/ Madam

World Health Partners (WHP), a non-profit Indian society, having its administrative office at A-151, Block A, Sector-72, Noida-201301, India and project office at 11, first floor, Uplav society, near Bansighar garden, Narayan nagar, Paldi, Ahmedabad-380007/___(Jharkhand office address)___ is implementing "Closing the Gaps in TB Care Cascade project". The project aims to strengthen TB control efforts in Gujarat/ Jharkhand by engaging healthcare providers, CXR facilities & Chemist. The project recognizes their role in identifying the gaps in early diagnosis, missing cases in notification, early TB treatment and other elements in TB cases. The Diagnostic/ X-Ray Labs can play a crucial role in early TB case identification, specially focusing on high risk/ vulnerable populations.

CGC project is currently having its intervention with healthcare providers, chemist wherein they are being sensitized and screened for Tuberculosis. The presumptive patients will be given facility for free X-Ray to identify for tuberculosis in this project. WHP with the Diagnostic Lab aims at:-

- 1. Facility will provide free Chest X-Ray to all the presumptive patients referred from providers engaged with World Health Partners and give diagnostic reports for the same. No any other x-ray will be entertained with this agreement.
- 2. All the presumptive will submit a referral coupon (with voucher ID) for availing free X-Ray facility at the facility. if any patient turned up with free referral coupon without voucher mentioned, facility need to generate ID either by calling at call center or by fill the details in the given application. In that case facility will have to first generate the ID and upload the image & report after X-ray.
- 3. Facility will be given a web application where patient ID wise X-ray image along with report need to be updated by the facility.
- 4. Facility is willing to upgrade and ready to use Artificial Intelligence application when launched at their facility.
- 5. Facility will allow World Health Partners to paste a poster or circulate the facility name with the engaged provider.
- 6. Facility will nominate at least one person to participate for virtual training organised by World Health Partners on Ni-kshay or related matter
- Comply and make sure all your representatives also comply with all Privacy Laws in respect of all Personal Information collected, used, disclosed and otherwise handled by you under or in connection with this Agreement
- 8. Use personal information it obtains only for the Approved Purpose; and
- 9. Take reasonable steps to protect the personal information it holds from misuse and loss and from unauthorized access, modification or disclosure.
- 10.Facility has to abide by the WHP's data privacy policy (Privacy Policy means WHP internal Data privacy policy, which can be viewed at www.worldhealthpartners.org/privacy)
- 11.Facility will be paid Rs.______ per X-Ray conducted for the providing free X-ray service to the patients. The amount will be reimbursed on fortnightly basis on submission of complete information / X-Ray report of all patients & referral coupons after deduction of taxes as applicable.

12.Current MoU will remain in existence till ______. Charges per X-ray may be revised after the completion of one year/ 365 days from the signing date. Contract/ MOU may be terminated by either of the party by providing one month notice period.

13. ______ will not stand legally responsible for any matter related to CXR interpretation/ report by AI/ WHP, based on which further treatment by any private provider (Qualified/ non-qualified) & clinical/ treatment outcomes of patients.

WHP reserves the rights to change, alter or cancel this arrangement at any time by giving a written notice without assigning any reason. In that case, Diagnostic Lab will be paid for already rendered services.

In case this interests you, please sign the copy of this agreement as your acceptance

Strategy Lead, ____(State name)___

I hereby agree to the above terms and conditions

Signature of Radiology facility owner

Date To World Health Partners A-151, Block A, Sector-72, Noida-201301, India

Dear Sir,

With reference to your offer letter number dated	, I Dr./ Mr.
S/O	- holder of identity
(PAN or AADHAAR number) representing	
agree to the following:	

- 1. I acknowledge that I have read the offer letter and I accept all the terms and conditions.
- 2. I am owner of a registered Diagnostic Lab -----
- 3. I shall provide information of presumptive & confirmed TB cases that are referred by World Health Partners for chest X-Ray TB.
- 4. I also agree to provide all relevant data/ records related with presumptive TB referred to facility for X-Ray to WHP, and upload the x-ray images and reports on application or whenever it is required for any audit, verification or other purposes.
- 5. I fully understand that this engagement is limited to proving only for the Chest X-Ray TB facility @ Rs----- per X-Ray along with report. In no case, this relationship exceeds beyond a purchaser and seller of services. This means, in no circumstance, I am authorized to represent the WHP project. I will not take any action that can be construed as representation on behalf of WHP.
- 6. I understand and take full responsibility for any untoward incidence caused by negligence, deficiency in service delivery or discharge of duties as Diagnostic Lab representative. This means, I agree to indemnify WHP for any such liability caused due to negligence of deficiency in service delivery or discharge of my duties at my part.
- 7. I Will comply and make sure all representatives also comply with all Privacy Laws in respect of all Personal Information collected, used, disclosed and otherwise handled by that party under or in connection with this Agreement
- 8. I will use personal information it obtains only for the purposes as declared in the agreement; and
- 9. I will take reasonable steps to protect the personal information it holds from misuse and loss and from unauthorized access, modification or disclosure.
- 10. Each party (an "Indemnifying Party") agrees to defend, indemnify and hold harmless the other Party (the "Indemnified Party"), at the indemnifying Party's cost and expense, from and against any and all losses, costs, damages, fees or expenses ("Losses"). Losses shall include, without limitation, actual damages, attorney and expert witness fees, court costs, and other litigation expenses relating to or in connection with a third party claim arising out of (i) any breach by the Indemnifying Party of this Agreement, or (ii) any act, omission, gross negligence or wilful misconduct on the part of the Indemnifying Party, including any of its employees, contractors or agents, in performing its

obligations or exercising its rights under this Agreement. The foregoing shall not apply to the extent that any such Losses are attributable to the gross negligence or wilful misconduct of the Indemnified Party, including any of its employees, contractors or agents. In no event shall either Party be liable for indirect, special, punitive or consequential damages.

- 11. I will completely follow the WHP's data privacy norms ((Privacy Policy means WHP internal Data privacy policy, which can be viewed at www.worldhealthpartners.org/privacy)
- 12. I authorize WHP to directly deposit payments for all my dues in the following bank account.

Beneficiary Name	
Bank Account Number	
Type of Account	
Name and address of Bank	
IFSC code	
AADHAR No.	

- 13. In case, the beneficiary name is different from the name of the acceptor to these terms and conditions.
- 14. I fully agree to the indemnity clause described on point 10.
- 15. Indemnity if applicable: As I have authorized to pay my dues to a different beneficiary, (other than me), I take full responsibility, whatsoever arising to WHP due to payment of my dues to this beneficiary account. I also irrevocably promise to indemnify WHP for any payment of liability of loss or damage including principal, interest or penalty imposed on WHP for claims arising from the obligation of this contract.
- 16. I declare that after making payment to this bank account, WHP stands fully discharged from its obligation to pay me or any of my successors for all dues arising from this contract.
- 17. In case of any discrepancy discovered by WHP or any authority on their behalf, I agree to refund the amount paid by them due to discrepancy.

Signature with stamp

Date, Place

Activity to Identify and Enroll TB patients from Community

Application for Participation in activity

World Health Partners (henceforth 'WHP') is a registered Indian Society which is implementing a project "Closing the Gaps in TB Care Cascade" in Jharkhand and Gujarat state with one of the mandate to identify the gaps in delay of diagnosis and suggest solutions to addressed & implement at large scale with state authorities.

Toward this objective, WHP has created an activity to support free CXR/ AI as pilot to all the presumptive TB patients through healthcare providers and chemist under which engaged provider and chemist will have to enroll the patient through call center/ web application and provide free CXR facility to all the presumptive patient for an early diagnosis and refer to allopathic provider/ public facility for further treatment on time.

Name of applicant	
Name of facility (if any)	
Father's /Husband's / Wife's Name	
Date of Birth (Age)	
Sex	
Complete Address	House No.
	Landmark
	Village
	TB Unit
	Block
	District
	State
	Country – INDIA
* Telephone/Contact no.	

The sections below give the tasks and responsibilities:

World Health Partners will:

- 1. Tie up with existing x-ray facility where patient can avail free x-ray facility
- 2. Extend coupon booklet to all the engaged healthcare provider/ chemist for free CXR
- 3. Extend list of CXR facility where presumptive TB patient could be referred for chest x-ray
- 4. Enrolled the presumptive patients on web applications and generate voucher code to avail the free chest x-ray facilities
- 5. Provide the requisite training to providers (virtual or through Care Coordinator) for all workflows
- 6. Communicate the various norms and records that the members will have to maintain in future

The applicant is expected to:

- 1. Identify presumptive TB patients
- 2. Enroll on web application (yourself or through call center)
- 3. Generate chest X-ray voucher ID
- 4. Fill the details in voucher and give it to patients
- 5. Refer presumptive TB patient for free chest x ray

- 7. Refer the patient with abnormal chest x ray to network providers for further consultation
- 8. Comply and make sure all your representatives also comply with all Privacy Laws in respect of all Personal Information collected, used, disclosed and otherwise handled by you under or in connection with this Agreement
- 9. Use personal information it obtains only for the Approved Purpose; and take reasonable steps to protect the personal information it holds from misuse and loss and from unauthorized access, modification or disclosure.
- 10.Privacy Policy means WHP internal Data privacy policy, which can be viewed at <u>www.worldhealthpartners.org/privacy</u>

Other clauses:

- 1. WHP will not be responsible for any disputes between provider and patient
- 2. WHP is not responsible for any diagnostic and treatment decisions taken by the provider and resulting outcomes
- 3. WHP reserves the right to disengage any provider from the project at any point of time
- 4. All disputes between a member and WHP will be decided by arbitration according to the Arbitration and Conciliation Act. For all purposes the jurisdiction of this agreement shall be New Delhi.

I have read and understood the terms and conditions detailed in this application. I accept them and hereby apply for membership to the Scheme.

Signature Name of the applicant Date

IEC & Capacity Building

IEC material would be developed for better engagement and to improve the access to the services.

- 1. Demand generation/ Value creation protocol (i.e. IEC content indicating free CXRs are available at selected CGC facilities for all the presumptive TB patients)
- 2. CXR voucher
- 3. Certificate of Association
- 4. Certificate of Appreciation
- 5. Patient feedback
- 6. Recognition for special contribution etc.
- 7. Visual aid (What is qure.ai, Process flow, Outcome) for CCs
- 8. TB related updates for virtual engagement

Capacity Building

Project staff will be oriented over following, but not limited, topics:

- 1. Basics of TB (Global and national burden, Types/ classification of TB, Diagnostic Modalities, Treatment regimens, Gazette for Notification, Importance of Private sector engagement etc.)
- 2. Health & NTEP structure, Private Sector engagement efforts of relevant districts
- 3. CGC Project brief including major achievement along with detailing of AI/ DeepTek
- 4. Provider Engagement Questioning Skills, pre-call planning, crafting engaging statements, active listening, building the relationship
- 5. Pitch to engage providers & scripts for role plays for the same is developed, as under, to train project staff. This may be modified based on learnings.

Annexure – 7

Pitch to engage Radiologist/ X-ray Facility owner

Dear Madam/ Sir, Greetings/Namaste/Namaskar!

I am ------ (introduce self) from World Health Partners (WHP), WHP is a non-profit organisation working in health from last 12 years and Tuberculosis project specially from last 8 years. This project Closing the gaps in TB Care Cascade (CGC) is being implemented with support of USAID along with State Tuberculosis Office of Jharkhand and Gujarat. One of the project mandates is to identify gaps in early diagnosis of TB in patients in coordination with District TB Officers (DTOs). As you are aware that the government is committed to eliminating TB from India by 2025. We (WHP) have an experienced and dedicated team to support the TB elimination programme in the state of Jharkhand/Gujarat. As all of us know that two possible solutions to eliminate TB from our society are following:

Diagnose all the people having TB symptoms as early as possible and get them on treatment &
 Complete the treatment of all existing TB patients.

For identification of TB patient, x-ray is playing a vital role. We are happy to see that you are running an x-ray facility in this locality. We would like your involvement in the national programme of TB elimination. It will not take much of your time to discuss your involvement in the CGC project. I am sure it will not take more than 5 - 10 minutes of your time. For this I need to enter some of your details in our application/format/software.

Complete the mapping part of that facility

In urban areas people having cough, fever or both, used to contact qualified doctors but in rural areas any person who is having cough or fever are first contacting chemist shops or health providers available in and around their village. It has also seen that they are being treated for a few weeks without any diagnosis which is one of the major reasons for delay in diagnosis of TB cases. WHP has come up with an innovative reimbursement model for TB test. WHP has tied up with chemists and health providers of this area and given coupons for free x-ray so that as soon as any person comes to them with symptoms of cough along with fever, can be referred for free x-ray. It will help you to get more caseload from the community through our project team. As per the proposal you will be required to give free service for Chest X Ray to those patients and the WHP will pay you per patient on behalf of that patient. Hope this proposal is more suitable to you and your work. If you agree with this arrangement, we can discuss it further for your engagement with WHP for TB Program

The process of engagement.

Step 1: Formal Agreement: As a formal agreement, you will be required to give free x-ray only for Chest X-ray who are coming to you with a free coupon issued to them by the healthcare providers, chemists engaged by the WHP team.

Step 2: Distribution of the referral coupons: Each patient will come to you with a referral coupon with a unique voucher ID, name of patient and contact number mentioned. You will be required to keep that copy with you and provide the free service to the coupon holder. On monthly basis you will be required to submit a bill enclosed with coupons to Care Coordinator and WHP will reimburse the amount in your given account.

Step 3: Reports and use of web application : You will be required to update the Chest X ray report along with images on the application that is given to you for each of the patients.

Step 4: Reimbursement process: You will be required to raise a bill on fortnightly/monthly basis with referral vouchers. For all the reports you will upload in the app, will be cross checked with coupons against your bill raised, you will be reimbursed.

I would like to inform you about another innovative model which is going to be implemented in the next phase in this project is an artificial intelligence based automated Chest X-ray report. For this, WHP has a tie up with an organization named "DeepTek". So whatever chest x-ray you perform at your facility and upload in the application, you will be able to have a report through this software. Are you willing to get that software for your facility?

If the facility owner agrees, engage them and get the agreement and application form filled by them. If facility has any doubt, clarify that and close the call.

Closing note :

Sir/Mam, I appreciate the time you took for this discussion. Is there anything you would like to know about this project, proposal and model so that I can brief you further. Thank you once again. I have your contact information and would like to call you if we need any further information. Thank you.

Things to carry during Pitching

- A detailed PPT including above details (Include DeepTek)
- Sample copies of referral coupon
- link from web application
- Application form/Agreement paper

Pitch to engage Healthcare Provider

Dear Madam/ Sir

Greetings! I am ------ from World Health Partners, WHP is implementing a project Closing the Gap in TB Care Cascade (CGC) to identify gaps pathway of TB patient (identification, diagnosis, treatment period and post treatment follow-up) along with State and District TB Officers. As you are aware the government is fully determined to eliminate TB by 2025 so we all are working towards achieving the goal of TB elimination. As all of us know that two possible solutions to eliminate TB from our society are:

Diagnose all the persons having TB symptoms as early as possible and get them on treatment &
 Complete the treatment of all existing TB patients.

As you are already referring such patients to the nearest health facilities and patients are coming to you for treatment which may have TB symptoms, I am here today to discuss more so that you also can play a vital role in this Noble cause. Our project is mapping all the health care providers so that we can create a smooth pathway for such patients to get diagnosed early and treated on time. I need your little time where I need to enter some of your details in my application.

Complete the mapping activity-----

Are you getting patients suffering from cough, fever, weight loss etc.? All these are symptoms for TB so it might be possible he/ she is suffering with TB and needs further investigations for diagnosis and treatment. Currently what are you doing with such patients?

After getting answer which may be like prescribing antibiotic, carrying out investigations, refer to allopathic private provider or to public sector etc. start as below:

WHP brings solutions for those kinds of patients. WHP is offering a free x-ray for all of them. Do you think this will help you in identifying TB cases? This will add value to your reputation in the community. So based on the discussion as of now would you be interested to join us in this activity, for this association there is no financial investment required from your end.

If he/ she is agree - brief them on referral coupon system. The process of engagement.

Step 1: Formal Agreement: - As a formal engagement you will have to sign the application form as your acceptance and willingness to refer presumptive cases for diagnosis.

Step 2: Use of Call Center or web application: - Whenever any patient comes to you with symptoms like coughing from more than 15 days, cough with fever, weight loss, loss of appetite etc. which are the TB symptoms, you will contact call center at 8010111213 and update patient details. You may directly use the web application to update patient's details and you will get an unique voucher ID that will ensure that patient is registered in application, using which you can refer that patient for free x-ray.

Step 3: Distribution of Referral Coupon: - You will be given a booklet of 25 coupons which will have two parts. As and when you come across any presumptive case, you will have to fill the coupon with his/ her name address, contact number and ID that you got from app or call center along with the name and address of x-ray facility where patient can get free x-ray service in both the parts. You will keep the doctors copy with you for future use and lab copy will be given to the respective patients. Patients will go to the designated x-ray facility and avail the free x-ray. He/ she not need to pay anything there for Chest x-ray.

Patient will come back to you with the x-ray report. You can treat the normal reported patient as you do. For all the abnormal x-ray reports (who may be suggestive of TB), should be referred to public sector or any allopathic private provider for further diagnosis and treatment.

We may also facilitate you in getting applicable incentives under various Government schemes. If he/ she agrees, get them engaged and get the application signed.

Closing note:

Sir/Mam, I appreciate the time you took for this discussion. Is there anything you would like to know about this project, proposal and model so that I can brief you further. Thank you once again. I have your contact information and would like to call you if we need any further information. Thank you.

Annexure – 8

Survey Questionnaire Tool for TB Patients availing the services of "Assist Ai"

Objectives:

Assess patient care-seeking pathway of patients availing services of "Assist Ai"; assess how a final diagnosis may have been informed

Introduction:

Hello, my name is ______ (Interviewer's name), and I work with World Health Partners, an independent non-governmental organization. We are conducting a survey about client experience with free Chest X-rays

Consent:

Thank you for your time! You are free to not answer any question or stop the interview at any time. If you agree, we would like to record this call, for quality check purposes. Do you have any questions?

Are you happy for us to proceed with this interview?

- Yes, and you can record
- Yes, but without recording
- No

We thank you for your time to help us with this important work.

Note: Text marked in blue below are instructions for the tele caller / interviewer, not to be read to patient.

Patient Questionnaire

Were you provided a free CXR voucher by Provider X?* (Match with Provider Name in sheet)

- 1. Confirm the patient's registration date/ voucher generation date from excel file.
 - Confirm name of the referring provider X to see if patient is aware of the name
 - a. Yes
 - b. No (skip to 19a probe if patient visited referral provider X and note in remarks)
 - c. Pending
 - d. N/A
- 2. What symptoms did you have when consulting with referral provider X?* (Multiple selection)
 - a) Cough for two weeks
 - b) Fever
 - c) Night sweating
 - d) Loss of appetite
 - e) Weight loss
 - f) Other
 - g) N/A
 - 2a. other specify _____

- 3. When did you experience your FIRST symptom? * (Date should be before the CXR youcher generation date)
- 4. How many different providers did you visit to get help for these symptoms? Please also include all pharmacists/chemists, doctors, both government and private) ----- (Count of Number)
- 5. What date did you first visit referral Provider X for these symptoms?
- 6. What date did you receive the CXR voucher from this Provider X?
- _____
- 7. What date did you get the X-ray done? * (Refer to date of "get voucher" and date of image and report uploaded for reference; date of X-ray done should not be after date of image/report upload or less than date of get voucher) _____
- 8. Time of free X-ray done * Mark only one.
 - Morning a)
 - b) Afternoon
 - c) Evening
 - d) N/A
- 9. Did you return to the Provider X with the X-ray report?
 - Yes a)
 - b) No Skip to question 12
 - N/A Skip to guestion 12 c)

- 10. What date did you return to Provider X with the X-ray report?
- 11. Time of Return visit to Provider X *Mark only one oval. (CCE can take the name of provider while interacting with patients)
 - Morning a)
 - Afternoon b)
 - Evening
 - N/A c)
- 12. Did Provider X refer you to another provider (Y)?
- 13. If yes, who did provider X refer you to?
 - Doctor _____ (get the name) a.
 - b. Private clinic _____ (get the name)
 - Govt' hospital_____ (get the name) c.
 - Other qualified MBBS/MD/Renowned doctor? d.
- 14. Did you visit provider Y?
 - a. Yes
 - b. Not yet but plan to visit in the near future
 - No and I don't plan to do c.
- 15. Did you visit any other provider on your own?
 - a. Yes
 - Not yet but plan to visit in the near future b.
 - No and I don't plan to do c.
- 16. Have you received any final diagnosis for your symptoms?

*Mark only one oval.

- a. TB diagnosis
- Non-TB diagnosis b.
 - Specify Non-TB diagnosis _____ (list drop-down of the i.
 - conditions that DeepTek providers
- No diagnosis received yet / Pending c.
- Skip to question 17

17. Who gave you this final diagnosis?

d.

Symptoms gone, no diagnosis required Skip to question 17

- a) Provider X
- b) Other Doctor
- 18. Other Doctor's name _____ (if 13b is selected)
- 19. What date did you consult this diagnosing doctor?
- 20. Did this diagnosing doctor order any additional tests?
 - o None
 - o Sputum microscopy
 - o CXR
 - o Blood test
 - o Others
 - o N/A

Background patient information

- 21. Please tell me the type of ration card do you have? *Mark only one oval.
 - a) Above poverty line
 - b) Below poverty line
 - c) No card
 - d) Refuse to answer

22. Types of residence * Mark only one oval.

- a) Urban
- b) Rural
- 23. Please tell me the type of house you live in *Mark only one oval.
 - a) Kutcha house
 - b) Pakka House
- 24. Please tell me the education level of the main earner of the family* (Mark only one oval).
 - a) Illiterate
 - b) Literate but no formal schooling/ School upto 4 years
 - c) School-5 to 9 years
 - d) SSC/ HSC
 - e) Some College (including a Diploma) but not a degree
 - f) General Graduate/ Post Graduate degree (e.g. B. Com., B.Sc., B. A. etc.)
 - g) Professional Graduate/ Post Graduate degree (e.g. doctor, engineer, architect, lawyer etc.)

Remarks (if any)

Annexure – 9

IEC Materials



Project Briefer

Intervention Booklet





Training and Capacity Building of Private Providers

Annexure – 10

Metrics for the iSMART Power Bi Dashboard

	Sr. No	Metric	Numerator	Denominator
Cases	1	Number of Cases Registered with a Free CXR	Number of unique beneficiary_id with a voucher_ id not blank	Beneficiary Register
	2	% of Cases with a resulted CXR	Number of cases with Suggestive of TB does not = blank/Null/0	Number of unique beneficiary_id with a voucher_ id not blank
	3	% of resulted Cases with an abnormal CXR	Number with Suggestive of TB = Suggestive of TB or abnormal	Number of cases with Suggestive of TB does not = blank/Null/O
	4	% of resulted Cases diagnosed with TB (out of abnormal)	Number with Date of Diagnosis does not = blank (with valid value)	Number with Suggestive of TB = suggestive of TB or abnormal
	5	% of resulted Cases with unknown diagnosis (out of abnormal)	Number with Date of Diagnosis = blank (no valid value)	Number of cases with a value in Suggestive of TB (not blank/Null/ 0)
	6	% of resulted Cases with a normal CXR	Number of cases with Suggestive of TB= normal	Number of cases with Suggestive of TB does not = blank/Null/0
	7	% of Cases diagnosed with TB (out of normal)	Number with Date of Diagnosis does not = blank (with valid value)	Number of cases with Suggestive of TB = normal
	8	% of cases with unknown diagnosis (out of normal)	Number with Date of Diagnosis = blank (no valid value)	Number with Suggestive of TB = normal
	9	Total TB cases identified	Number with Date of Diagnosis does not = blank (with valid value)	
Provid er	10	Number of Active Referring Providers	Number of unqiue registering provider id	
Activty	11	Number of Active Labs	Number of unique lab_id	

Delays	12	Delay from Registration to Voucher generation (in days) (in hours)	Date_of_voucher_genera tion minus Date_of_registration (averaged across unique beneficiary_ids where Date of registration does not= blank and date of voucher generation does not = blank)	
	13	Delay from Voucher Generation to Date of report upload	Date_of_report_upload minus Date_of_voucher_genera tion (averaged across unique beneficiary_ids where Date_of_report_upload does not= blank and Date_of_voucher_genera tion does not = blank)	
	14	Delay from Report Upload to TB Diagnosis	Date of Diagnosis <i>minus</i> date_of_report_upload (averaged across unique beneficiary_ids where Date of Diagnosis does not= blank and date_of_report_upload does not = blank)	
	15	Delay from Registration to TB Diagnosis	Date of Diagnosis <i>minus</i> Date_of_registration (averaged across unique beneficiary_ids where Date of Diagnosis does not= blank and date_of_registration does not = blank)	
Provid er-wise	16	Number of cases registered with a CXR	Metric #1 collapsed provider-wise	
reports	17	% of resulted Cases with an abnormal CXR	Metric #3 collapsed provider-wise	
	18	% of resulted Cases diagnosed with TB (out of abnormal)	Metric #4 collapsed provider-wise	
	19	% of resulted Cases diagnosed with TB (out of normal)	Metric #7 collapsed provider-wise	
	21	Number of TB cases identified	Metric #9 collapsed provider-wise	
	22	% Contribution to TB cases	Metric #20 (provider- wise)/ Metric #9	