Screening difficult-to-reach populations for tuberculosis using a mobile medical unit, Punjab India

G. Binepal,[1] P. Agarwal,[2] N. Kaur,[3] B. Singh,[4] V. Bhagat,[3] R. P. Verma,[3] S. Satyanarayana,[5] J. E. Oeltmann,[6] P. K. Moonan[6]

Background: In India, the National Health Mission has provided one mobile medical unit (MMU) per district in the state of Punjab to provide primary health care services for difficult-to-reach populations.

Objectives: To determine the number of patients with presumptive tuberculosis (TB) and the number of TB cases detected and treated among patients who used the MMU services from May to December 2012 in Mohali district, Punjab, India.

Methods: A cross-sectional study was conducted and registers of the out-patient, laboratory, radiology, and TB departments of the MMU were reviewed to determine the number of persons presumed to have TB and the number of persons diagnosed with TB.

Results: Of 8346 patients who attended the MMUs, 663 (8%) had symptoms suggestive of TB. Among those with TB symptoms, 540 (81%) were evaluated for pulmonary TB using sputum examination or chest X-ray. In total, 58 (11%) patients had clinical or laboratory evidence of pulmonary TB, of whom 21 (36%) started anti-tuberculosis treatment.

Conclusion: As MMUs are an integral part of the general public health system, these units have the potential to detect TB cases among difficult-to-reach populations. Additional research is required to optimise the diagnosis of TB at MMUs and to increase rates of TB treatment initiation.

In many countries, public health departments are using innovative strategies to improve the reach and accessibility of health services for a variety of conditions.[1–9] India is a low- to middle-income country, with approximately 30% of the population earning below the international poverty line (US$<1.25 per day).[10] Despite a well-developed public health system, many populations in India remain either underserved or without access to the health services available from the public health facilities.[11–14] To enhance access to care and create an equitable distribution of health services across the country, the government of India created the National Rural Health Mission (NHRM). The NRHM has undertaken many initiatives to provide health care to underserved populations, including providing one mobile medical unit (MMU) in each district to increase the accessibility of public health services, especially in remote or difficult-to-reach locations. MMUs are vehicles equipped with basic diagnostic and treatment facilities that can move from one place to another, and which can provide opportunities for early, improved detection of a multitude of health conditions, particularly those of public health importance.

Tuberculosis (TB) is a major public health problem in India.[15,16] Although TB diagnosis and treatment are available at all government health facilities through the Revised National Tuberculosis Control Programme (RNTCP),[17] some at-risk populations are unable to access these TB services, thus remaining undetected and untreated.[13] As MMUs are now an integral part of the general health system, offering services to remote or difficult-to-reach populations, they can be used to increase access to TB diagnostic and treatment services in the communities they serve. However, the results of MMUs for specifically screening, diagnosing and linking TB patients to treatment services have not been documented.

We undertook an operational research study among people using the medical services of an MMU in Punjab, India. As this was the first time that the MMU was being used for the screening and diagnosis of TB patients in India, it was anticipated that some challenges would be encountered. We therefore sought to identify and document 1) the proportion of people accessing the MMU medical services who were found to have presumptive TB; 2) the proportion of presumptive TB patients diagnosed with TB by the MMU; 3) the proportion of people diagnosed with TB who started treatment; and 4) the challenges faced during screening.

METHODOLOGY

Study design

This was a population-based descriptive cross-sectional study.

Setting

The study was conducted in the Mohali district (population 1 million) in the northern state of Punjab, India. In 2012, 67 378 new sputum smear-positive patients were diagnosed and 100 966 patients with TB were treated in the state of Punjab.[16] MMU field visits were conducted to underserved communities in remote and vulnerable areas (e.g., urban slums, brick kilns and construction sites) where it was assumed that the population had difficulty in accessing health services.

Services provided by MMUs in Mohali district

Each MMU, with a staff of two medical officers, one nurse, one laboratory technician and one radiogra-

AFFILIATIONS
1 District Tuberculosis Centre, Mohali District, Punjab, India
2 Department of Tuberculosis, World Health Organization Country Office for India, New Delhi, India
3 Civil Hospital Mohali District, Punjab, India
4 Directorate of Health Services, Punjab, India
5 International Union Against Tuberculosis and Lung Disease South-East Asia Regional Office, New Delhi, India
6 Division of Tuberculosis Elimination, US Centers for Disease Control and Prevention, Atlanta, GA, USA

CORRESPONDENCE
Patrick K Moonan
Division of Tuberculosis Elimination
US Centers for Disease Control and Prevention
1600 Clifton Road NE
MS-E10
Atlanta, GA 30333
USA
e-mail: pmoonan@cdc.gov
Fax: (+1) 404 639 1566

pher, is under the overall administrative control of the Chief Medical Officer of the district. The routine services provided by the MMU are general out-patient medical consultations, laboratory investigations (e.g., haemoglobin, total leukocyte count, differential leukocyte count, non-fasting blood sugar and urinalysis), electrocardiography, radiography and pharmacy. While medical consultations are provided free of charge, nominal charges are levied for diagnostic investigations (Indian Rs. 125, US$1.90). All services provided by the MMU are documented in an out-patient department (OPD) register, a laboratory register and a drug dispensing register.

As part of this demonstration project and prior to the scheduled visit of the MMU, the public health field workers (auxiliary nurse midwife and accredited social health activist) informed the local communities about the MMU visit. Persons with a cough of >2 weeks were given sputum containers and requested to go to the MMU with an early morning sputum sample. On the day of the MMU visit to the community, the MMU staff welcomed those persons who were identified and any person who presented for care. Each MMU visit began at 8 am and ended at approximately 2 pm, or until the last person waiting in the queue was evaluated. The MMU medical staff were trained to recognise presumptive TB, order appropriate diagnostic investigations (e.g., posteroanterior and lateral chest radiographs [CXR], and sputum smear microscopy), and link persons with TB disease to the RNTCP treatment services. The laboratory technician of the MMU was trained to perform Ziehl-Neelsen (ZN) sputum smear microscopy and to maintain a laboratory register according to RNTCP guidelines.[17]

Study period and study population

During the period of observation, from May 2012 to December 2012, all persons from Mohali district who had used the services from the MMU were included in the analysis.

All persons attending the MMU were screened for TB with a standardised medical examination and interview. All patients with signs and symptoms suggestive of pulmonary TB (e.g., prolonged cough >2 weeks, night sweats, fever, unexplained weight loss) were referred for sputum smear microscopy and CXR in the MMU. The CXRs were inspected for image quality by the radiographer before presentation to the medical officer for review and clinical diagnosis. If an abnormality was discovered, the second officer reviewed the film for concurrence. If the medical officer's reading was found to be discordant, the film was reviewed by the Chief Medical Officer for final decision. Because conventional radiography is limited in specificity, clinical suspicion was high for these individuals; all patients with abnormalities consistent with pulmonary TB were screened by sputum smear microscopy.

All sputum smear-positive patients were referred to the medical officer in charge of the nearest health facility for initiation of anti-tuberculosis treatment in accordance with RNTCP guidelines.[17] Patients who were sputum smear-negative and had CXR features sugges-

tive of TB were re-examined by a clinician and a radiologist for classification as clinical TB at the district or subdistrict level. Patients with sputum smear-negative TB or with symptoms or CXR evidence suggestive of TB were also offered anti-tuberculosis treatment.

Definitions, variables and sources of data

Persons presumed to have TB were defined as all patients with cough of ⩾2 weeks with/without any other associated symptoms, or any patient referred for TB investigations. We categorised the patients into three groups: 1) sputum smear-positive TB patients were all those who were positive for acid-fast bacilli (AFB) by ZN staining based on at least one sputum smear microscopy; 2) sputum smear-negative pulmonary TB patients were all those who were AFB-negative, but had CXR features suggestive of pulmonary TB; and 3) persons with symptoms and radiological features suggestive of TB on CXR but who did not undergo sputum smear examinations were labelled 'presumed clinical TB'.

Demographic (age, sex) and clinical information were abstracted from the MMU OPD register, laboratory register, RNTCP TB registers, treatment cards, radiographic reports and monthly peripheral health institution (PHI) reports of the MMU using a standardised data collection instrument. At the conclusion of the study, we documented any logistical and programmatic challenges through informal interviews with all MMU staff. Key themes were identified, categorised and summarised.

Data management and analysis

Data collection forms were double-entered into a master database created in EpiData software version 3.1 (Odense, Denmark). There were no instances of discordance from the double data entry. Simple frequencies and percentages were tabulated for all variables. Pearson's χ^2 tests were used to compare differences in proportions between groups. We compared four groups of patients receiving care at the MMU: those presumed to have TB, those evaluated for TB, those diagnosed with TB and, among those diagnosed, those started on anti-tuberculosis treatment. A P value of < 0.05 was considered statistically significant.

Ethics clearance

The study protocol was reviewed and approved by the Ethics Advisory Group of the International Union Against Tuberculosis and Lung Disease (Paris, France) and the Institutional Ethics Committee of the National Tuberculosis Institute, Bangalore, India. Permission for the study was also obtained from the Director Health Services and the State TB Officer, Punjab.

RESULTS

During the study period, there were a total of 127 field screening days at 127 different locations. The MMU staff attended to a total of 8346 persons (average persons screened per visit, $n = 66$). Among these, 663 (8%) were determined to have symptoms suggestive of pulmonary TB. Of those with TB symptoms, 540 (81%)
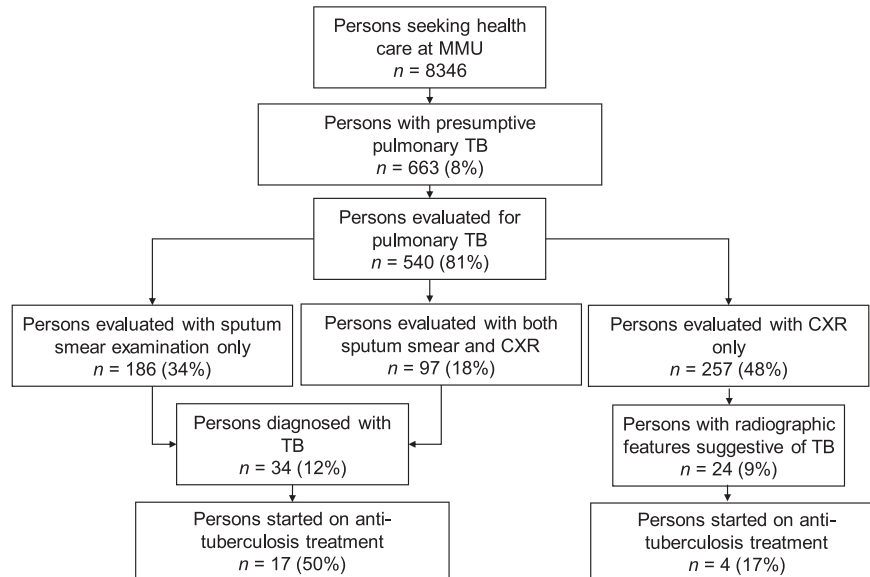
FIGURE Screening and diagnosis of pulmonary TB among persons using medical care from MMU in Mohali district, Punjab, India (May–December 2012). MMU = mobile medical unit; TB = tuberculosis; CXR = chest X-ray.

were further evaluated for TB: 186 (34%) with sputum smear examination only, 97 (18%) with both sputum examination and CXR and the remaining 257 (48%) with only CXR. Of those evaluated, 34 TB patients were diagnosed by sputum smear microscopy and CXR; 17 (50%) started anti-tuberculosis treatment. Among those evaluated with CXR alone (without sputum smear examination), 24 patients had radiographic features suggestive of TB and 4 (17%) started anti-tuberculosis treatment. In total, 58 patients were diagnosed with TB either due to sputum smear positivity or because of CXR evidence suggestive of TB (Figure).

The demographic characteristics of patients with symptoms suggestive of TB are provided in Table 1. Although the proportion of males investigated for TB was greater (84% vs. 79%, $P = 0.05$), the proportion of males who started anti-tuberculosis treatment was smaller (25% vs. 47%, $P < 0.05$) compared to females. Fewer children (aged <15 years) were investigated for TB compared to other age groups ($P < 0.05$). Following a diagnosis of TB, no patients aged <15 years and less than a third of patients aged >60 years started treatment.

Challenges in screening hard-to-reach populations for TB through MMUs are summarised in Table 2. These included staff-ing and supply shortages, marketing and scheduling challenges and tracing migrant populations.

DISCUSSION

This is the first study from India to describe case-finding activities using MMUs to target hard-to-reach populations for TB screening and treatment. Approximately 8% of patients screened by the MMU had symptoms suggestive of TB, and nearly four out of five persons with TB symptoms underwent additional investigations for TB (18% with both sputum smear microscopy and CXR, 48% with CXR alone and 34% with sputum smear microscopy alone). About 1 in 10 persons presumed to have TB were diagnosed with TB and, of these, only 1 in 3 started anti-tuberculosis treatment.

These findings have three key programmatic implications. First, the RNTCP has a policy for universal access to TB care, by which it aims to 'reach the unreached' through quality TB diagnostic and treatment services.[13,18] As the philosophy of operating MMUs has a similar aim, it follows that the RNTCP-specified TB diagnostic and treatment services should be made available through the NRHM MMUs across the country. Our finding that

TABLE 1 Demographic characteristics of patients with presumptive TB: status of evaluation, diagnosis and treatment of TB

	Presumed to have TB n	Evaluated for TB n (%)	Diagnosed with TB* n (%)	Started anti-tuberculosis treatment n (%)
Total	663	540 (81)	58 (11)	21 (36)
Sex				
Male	312	262 (84)	28 (11)	7 (25)
Female	351	278 (79)	30 (11)	14 (47)
Age group, years				
<15	74	53 (72)	2 (4)	0
15–60	378	310 (82)	32 (10)	14 (44)
>60	210	176 (84)	24 (14)	7 (29)
Unknown	1	1	0	0

*Including patients with radiographic features suggestive of TB.
TB = tuberculosis.

TABLE 2   Challenges identified in screening hard-to-reach populations for TB through mobile medical units in Mohali, Punjab, India, 2012

Challenges identified
In bringing persons with TB symptoms to attend the OPD of the MMU:
Some populations were not aware of the MMU's visit to their localities, as it was not adequately publicised by the peripheral health workers
In some places, support from local bodies (village panchayat [local government] and village health sanitation committee) was lacking and as a result community mobilisation did not occur as desired
Timing of the MMU visit (8 am to 2 pm) was not appropriate for many people as they were working
In investigating patients with TB symptoms for TB disease:
As the MMU visited a particular area only once a month, it was not possible to obtain early morning sputum samples from many patients
The generator was operational for limited periods of time, resulting in fewer microscopy examinations and CXRs for persons presumed to have TB
The LT went on prolonged leave (for more than a month) and no alternative arrangement was made by the general health system. During the LT's absence, persons presumed to have TB could not undergo sputum smear microscopy
The radiography unit was not functional for more than a month, either because the machine was not in working condition or due to non-availability of radiographic films
In linking TB patients for anti-tuberculosis treatment:
Delays in initiation of treatment because of non-availability of TB treatment services in MMU
Many TB patients were migrants who moved away from the area after the diagnosis of TB and could not be traced

TB = tuberculosis; OPD = out-patient department; MMU = mobile medical unit; CXR = chest X-ray; LT = laboratory technician.

8% of the MMU attendees had clinical features suggestive of TB was much higher than the 2–3% found among those attending other public health facilities,[6] a clear indication that the populations served by MMUs are in need of TB services. Second, sputum smear microscopy and CXR (the essential components of the RNTCP's TB diagnostic algorithm) can be made available through the facilities and resources already available through MMUs. To make these services more functional, some minimal expenditure (e.g., training, laboratory consumables) will be required. In addition, good coordination between RNTCP staff and the staff of the MMU will be essential to ensure continuity of appropriate care. Third, the study highlights potential operational challenges that may be encountered when conducting population-based field screening for TB using MMUs. Not all patients presumed to have TB underwent all the TB diagnostic tests, and loss to follow-up in this process was nearly 20%. It was difficult to evaluate all persons presumed to have TB as per RNTCP recommendations, because sputum smear microscopy is the primary test in the algorithm, followed by CXR. In this setting, sputum smear microscopy could not be undertaken for nearly half of those presumed to have TB due to the temporary absence of the laboratory technician or because of logistical challenges in obtaining an early morning sputum sample as part of a mobile field-based operation. This resulted in TB diagnosis based on clinical symptoms and CXR, a method previously reported as problematic.[19,20] Finally, there were further losses to follow-up after the diagnosis of TB was made because the linkages for treatment services could not be properly established. If TB screening and treatment are to be integrated into MMU practice, formal guidelines must be established with sufficient resource allocation to overcome these challenges.

This study does have some limitations. First, as is the case with all studies that require data abstraction from routine surveillance and medical records, the quality of the data may be limited. Surveillance registries and medical records are not designed for study purposes but rather to document clinical encounters and report illnesses of public health importance. Although all the registries and records used were subjected to routine health system supervision and monitoring, data transcription errors were possible. Second, we did not ascertain whether the costs of the tests were a potential barrier to receiving screening at the MMU. Third, we did not compare the relative yield of diagnosing TB among persons receiving services in generalised clinics of Punjab. Comparing the MMU results with generalised clinics would enhance the analytical design of the study. Fourth, as we did not follow the patients over time, there was no time limit to assess initiation of treatment. It is possible that some patients may have been diagnosed and treated later in time or elsewhere. Finally, the challenges narrated in Table 2 were not collected in a structured manner; they are simply a compilation of feedback and perceptions of key MMU staff at the conclusion of the study. Despite this limitation, we believe these perceptions highlight relevant programmatic challenges that are important for translating our findings into public health action.

CONCLUSION

Despite observing some operational and logistical challenges under mobile field conditions (i.e., providing all diagnostic tests necessary to confirm TB diagnosis and to start anti-tuberculosis treatment), we believe that through the development of standardised guidelines, training and appropriate resource allocation, including multiple day visits for each community, MMUs have the potential to detect TB among difficult-to-reach populations in India.

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Contexte : En Inde, la Mission nationale santé a fourni une unité médicale mobile (MMU) par district dans l'état du Penjab afin d'offrir des services de soins de santé primaires aux populations difficilement accessibles.

Objectifs : Déterminer le nombre de patients présumés atteints de la tuberculose (TB) et le nombre de cas de TB détectés et traités parmi les patients qui ont utilisé les services de la MMU de mai à décembre 2012 dans le district de Mohali de l'état du Penjab, Inde.

Méthodes : Une étude transversale a été réalisée et l'étude des registres des consultations, du laboratoire, de la radiologie et des services de TB de la MMU a permis de compter le nombre de personnes présumées atteintes de TB et le nombre de personnes ayant eu un diagnostic de TB.

Résultats : Un total de 8346 patients ont fréquenté la MMU, dont 663 (8%) avaient des symptômes suggérant une TB. Parmi ces derniers, 540 (81%) ont bénéficié d'une recherche de TB pulmonaire grâce à un examen de l'expectoration ou à une radiographie pulmonaire. Au total, 58 (11%) patients ont eu des preuves cliniques ou biologiques de TB pulmonaire, dont 21 (36%) ont mis en route un traitement de la tuberculose.

Conclusion : Comme les MMU font partie intégrante du système de santé publique général, ces unités ont le potentiel de détecter les cas de TB parmi les populations « difficiles à atteindre ». De plus amples recherches sont requises afin d'optimiser le diagnostic de la TB dans les MMU pour accélérer la mise en route du traitement de la TB.

Marco de referencia: En la India, la *National Health Mission* ha suministrado una unidad médica móvil (MMU) a cada distrito del estado del Punjab, con el objeto de prestar servicios de atención primaria de salud a las poblaciones de difícil acceso.

Objetivos: Determinar el número de pacientes con presunción clínica de tuberculosis (TB) y el número de casos de TB diagnosticados y tratados en el grupo de pacientes que acudieron a las MMU de mayo a diciembre del 2012 en el distrito de Mohali del estado del Punjab, en la India.

Métodos: Se llevó a cabo un estudio transversal, en el cual se examinaron los registros de los servicios de consulta externa, laboratorio, radiología y los departamentos de TB de las MMU, con el propósito de calcular el número de personas con presunción de TB y el número de casos de TB diagnosticados.

Resultados: Durante el período del estudio acudieron a las MMU 8346 personas, de las cuales 663 refirieron síntomas indicativos de TB (8%). Se investigaron 540 personas por TB pulmonar (81%) mediante la baciloscopia del esputo o la radiografía de tórax. Se encontraron pruebas clínicas o de laboratorio de TB pulmonar en 58 pacientes (11%) y se inició el tratamiento antituberculoso en 21 de ellos (36%).

Conclusión: Puesto que las MMU forman parte integrante del sistema general de salud pública, estas estructuras pueden detectar los casos de TB en las poblaciones de difícil acceso. Se precisan nuevas investigaciones que contribuyan a optimizar el diagnóstico de la TB en estas unidades y a conseguir que una mayor proporción de pacientes inicie el tratamiento antituberculoso.