FINDING MORE TB: Challenge TB helps national TB programs increase access to quality chest X-ray services in Cambodia and Myanmar

BACKGROUND

Challenge TB (CTB), USAID's flagship global TB mechanism from 2014-2019, worked closely with ministries of health and partners to contribute to the global End TB Strategy goals as well as to directly support national TB strategic plans.[1] In both Cambodia and Myanmar, CTB supported the national TB programs (NTP) to actively find and effectively treat missing people with TB, through a comprehensive TB detection, prevention and care approach. The projects focused on reaching those with poor access or vulnerable groups through approaches tailored to specific populations such as children, close contacts of TB patients, prisoners, those visiting hospitals and the elderly in Cambodia, along with people seeking care at drug sellers, contacts of drug resistant (DR) TB and those residing in hard-to-reach remote areas in Myanmar. In both countries, CTB also built the capacity of the NTPs through targeted assistance for guidelines, tools and policy development around key technical priorities.

CONTEXT

Prompt and accurate diagnosis of TB followed by treatment aligned with international standards improves health, curtails further transmission to others, and prevents death. Yet every year 3.6 million people are "missing" due to underreporting of detected cases or under-diagnosis, either because people do not access health care, or are not correctly diagnosed when they do. The World Health Organization (WHO) estimated that in Myanmar 191,000 people fell ill from TB in 2017, yet only 69% were diagnosed and reported. Similarly, in Cambodia only 67% of the 52,000 TB patients were reported to the NTP.[2] Both countries have improved laboratory TB diagnosis with the successful expansion of quality-assured sputum smear microscopy (SSM) services and the introduction and scale-up of rapid molecular diagnostics (i.e., GeneXpert). Yet many people with TB are still missed for reasons including care-seeking from private sector providers not linked to the NTP; the reliance on smear microscopy for first line TB testing, with low sensitivity especially in certain vulnerable groups; and the fact that approximately 50% are asymptomatic.[3,4] Other screening and diagnostic tools are needed to complement laboratory testing to help find the missing people with TB. Optimizing the use

1. WHO, "The End TB Strategy: Global strategy and targets for tuberculosis prevention, care and control after 2015," Geneva, 2014
2. GTR 2018
3. National TB Prevalence Survey, Myanmar, 2009/2010.
4. National TB Prevalence Survey, Cambodia, 2011.

of chest X-ray (CXR) in both Myanmar and Cambodia is one avenue towards achieving the WHO END TB Strategy goals of eliminating TB by 2035.[5]

Enhancement of CXR services can also help address the challenge of inaccuracy of childhood TB diagnosis. Both Myanmar and Cambodia have historically reported a much higher percentage of TB cases from children under 15 years of age than is expected. In 2014, prior to CTB, 26% of all reported TB cases in Myanmar occurred in children, while 26% of all TB was found in children in Cambodia.[6] Global experts expect that this should be closer to 10%. In Myanmar and Cambodia, it is highly likely that many children are over-diagnosed and treated for TB when in fact they have other illnesses with similar symptoms. Access to quality CXR services is essential to address this challenge.

RATIONALE

Both Cambodia and Myanmar must accelerate TB case-finding to meet the *END TB* targets to reduce TB deaths by 95% and decrease incidence by 90% by 2035. A major strategy to eliminate TB is to strengthen TB case finding through timely and accurate diagnosis of active TB. Since chest radiography is a sensitive screening tool and has a critical place in the screening and diagnostic algorithm, maximizing its utility is a crucial factor in early TB case detection. WHO has reconsidered CXR as a diagnostic tool that can be placed early in screening and triaging algorithms because of its high sensitivity, increased availability of digital radiography, and the rapid availability of results.[7] However, there are recognized challenges and limitations in the use of CXR including low specificity, inter-rater variation, lack of trained staff, and limited access to quality and safe digital CXR equipment.[8]

In Myanmar, the NTP committed to expand access to digital CXR service to all townships and ensure quality interpretation of CXR through proper training and external quality assurance (EQA) for CXR.[9] In Cambodia, an assessment of childhood TB activities found that 91% of clinicians requested more training on using CXR, including taking CXR and reading and interpreting radiographic films.[10] Furthermore, although all referral hospitals in Cambodia have CXR machines on site, the quality of developed films is variable in many facilities. Without good quality films, radiologists and physicians cannot conduct high-level, accurate reading/interpretation of the images. Both countries lack adequate quantity of and sufficiently trained human resources in the right locations to adequately produce and read sufficient quality CXRs for TB screening and detection.

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5. WHO, "The End TB Strategy: Global strategy and targets for tuberculosis prevention, care and control after 2015," Geneva, 2014
6. GTR 2015
7. WHO. Chest radiography in tuberculosis detection – summary of current WHO recommendations and guidance on programmatic approaches. Geneva, 2016.
8. WHO. Tuberculosis prevalence surveys: handbook. Geneva, 2011
9. Myanmar NTP. National Strategic Plan 2016–2022.
10. Frieze et all. Examining the quality of childhood tuberculosis diagnosis in Cambodia: a cross-sectional study. BMC Public Health. 2017 17:232.

EQA for CXR interpretation is defined as a planned and systematic approach to monitor and assess CXR interpretation at a health facility by an external independent re-reader.[11] EQA methodology is based on re-checking CXRs that have been read at facility level by an independent reference staff. Benefits of EQA include allowing comparison of performance and results among different readers, providing early warning for systematic problems, highlighting areas that need improvement, identifying training needs and ensuring both more accurate diagnosis of TB and better reliance of health care providers on complementary examinations. Efforts to improve production and interpretation of CXRs along with a system to ensure quality will not only improve case-finding, but also accuracy of TB diagnosis, especially in children, who are less likely to produce sputum and hence rely more heavily on radiographic procedures.

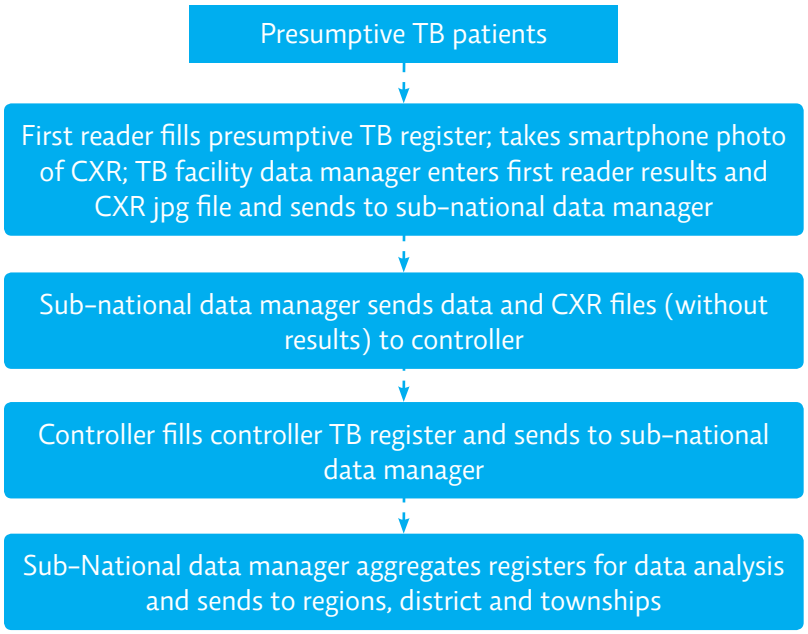
Continuity of quality assurance strategies can be challenging. Sustainable systems that do not over-tax already busy health care workers are needed. In both countries, "home-grown" solutions which take advantage of technological advances have been adopted and implemented through smart phone platforms following CTB interventions.

DESCRIPTION

Both CTB Cambodia and CTB Myanmar share the objective of strengthening TB case detection through CXR by instituting activities to improve quality, however initial approaches differed in their design and implementation. In Myanmar, CTB began CXR improvement by developing an external quality assurance (EQA) strategy. The team, led by a group of external experts, designed an EQA system for CXR interpretation in collaboration with the NTP, USAID, and WHO. This was the first CXR EQA activity to be implemented in Myanmar, or in any country, in a systematic fashion. The pilot included first readers who were township medical officers, and three levels of re-readers: district TB medical officers, regional TB medical officers and international experts. However, after evaluation stakeholders agreed to simplify the approach to include only a first reader at the township level and one re-reader (controller), either a district TB medical officer or a regional TB medical officer (Figure 1). The use of an international expert as a final controller was felt to be too expensive and human resource (HR) intensive for scale-up and hence was eliminated in the design for scale-up.

11. WHO Overview of External Quality Assessment (EQA). http://www.who.int/medicines/areas/quality_safety/quality_assurance/qas_eqaas/en/.

EXTERNAL QUALITY ASSURANCE FOR CHEST X-RAY – MYANMAR



The Myanmar team completed a feasibility assessment of CXR interpretation EQA to help identify how best to implement this approach countrywide. The results and experience gained during the study informed finalization of standard operating procedures (SOP) on how to use EQA of CXR interpretation in TB screening and diagnosis. CTB Myanmar then focused on building CXR capacity of clinicians at the township level.

CTB Cambodia started with a different approach by focusing on radiographers, radiologists, and clinicians, both doctors and nurses at referral hospitals. The team aimed to improve the capacity of staff at both national and referral hospital levels. Both teams adapted an international training curriculum to introduce and implement national training courses to improve CXR reading and interpretation, while Cambodia also established a course for radiographers and technicians on how to produce good quality chest X-ray films. The objectives of the courses were to improve diagnosis of TB and other pulmonary diseases; to limit over and under diagnosis of GeneXpert negative TB among adults and children; to train trainers on both CXR interpretation and supervision; and to promote a policy of rational use of CXR in TB diagnosis, including classification of CXR results, accurate recording and reporting, basic training on the country's TB diagnostic algorithm and quality control. In Cambodia, following the training, CTB conducted regular follow-up and on-site coaching to review CXR films and reinforce learning with TB clinicians, CXR readers and X-ray technicians at referral hospitals who had attended the course. In addition, external experts helped to identify a core team for CXR quality assurance at the national level to further train and monitor clinicians at subnational levels.

CXR INTERPRETATION TRAINING CURRICULUM, CAMBODIA

- Four-day course with 800 radiological images presented together in the clinical context
- Included CXR basics, criteria for quality image, thoracic anatomy and normal findings
- Identification of major chest syndromes
- Differentiation of inactive TB sequelae from other pathologies, such as non-TB lung infections or cancer, in those with Xpert negative sputum
- Specific CXR findings in TB among people living with HIV

In addition, in both countries, CTB together with the NTPs established a platform to continue to build capacity for CXR reading and interpretation through social media networks. A mobile application chat group was established with monitored dialogue, which is facilitated by a core team to respond to posted questions and CXR films from difficult cases. Information includes JPEG CXR images and clinical context sent via Facebook or Viber in Myanmar, or Telegram in Cambodia. This group then provides advice on diagnosis and patient management and there are safeguards to ensure confidentiality, as described below.

CXR INTERPRETATION TRAINING CURRICULUM, CAMBODIA

- Closed group requires invitation to join.
- Sharing to non-members is not allowed without permission.
- Administrator informs all members about confidentiality rules and requests group members to protect individual privacy rights.
- Message includes gender, age and short clinical history only.
- No names or other identifying information are included.
- Administrator sends monthly confidentiality alerts and monitors all posts for breach in procedure.

RESULTS

An EQA program for CXR interpretation along with capacity building efforts on both CXR interpretation and X-ray taking, as well as tools for ongoing support such as on-line social media groups and SOPs all have potential to improve TB diagnosis and increase TB notifications among those missing from national TB programs as well as to better identify children with TB.

In Myanmar, 23 participants including two regional TB officers and responsible staff from seven pilot implementing sites (two mobile teams and five township NTPs) were trained in the procedures of CXR EQA. During the EQA feasibility study at those seven sites, out of 851 presumptive TB patients, 836 CXRs were read at facility level. The median age of patients was 41 years and 49% were female. At facility level, 46% of patient's CXRs were read as normal, 32% reported as suggestive of TB, 9% showed healed TB, 8% were suggestive of a disease other than TB, 5% were inconclusive, and 0% not readable. Using an international reader as the gold standard, regional TB officers read more accurately (70% agreement rate) than district TB officers (67% agreement rate) who in turn read better than township TB officers (66% agreement rate). Although results of the EQA validation study were positive, the Myanmar NTP decided not to move forward with EQA for CXR immediately, but to first focus attention on capacity building of clinicians' skills in CXR interpretation. Eleven regional TB officers, five TB team leaders and eleven senior TB medical officers from different states and regions participated in a training-of-trainers (TOT) on CXR interpretation. The CXR Interpretation Module was distributed to all participants for later use in cascade trainings. Cascade trainings are currently rolling out across the country.

To increase TB case-finding in Cambodia, CTB provided trainings aimed at improving both clinicians' ability to read and interpret X-ray films, as well as X-ray technicians' CXR production skills in selected CTB and non-CTB supported hospitals. 114 clinicians, including 113 doctors and 1 nurse from 27 referral hospitals along with 29 X-ray technicians from 16 referral hospitals participated in the CXR training courses. In the six months following the training a CXR monitoring team consisting of NTP experts and FHI 360 CTB staff supported the 11 participating CTB-supported hospitals, where 2,563 CXR films from presumptive TB patients were taken during that period. 1,114 (43%) of the films were reviewed by the CXR monitoring team. Among those, 970 (87%) showed no sign of active TB, which was confirmed by both trained hospital clinicians and the monitoring team. However, 133 (13%) of the films that were interpreted as "no active TB" by hospital clinicians were confirmed as active TB by the CXR monitoring team. Those patients who were found to have been previously misdiagnosed were called back for treatment. The agreement rate on CXR reading of non-TB X ray films between clinicians at the hospitals and the monitoring team increased significantly within the five months of monitoring support post-training. The agreement rate increased from 81% at month one to 83%, 87%, 88% and 93% at months two, three, four and five, respectively.
In both countries, the easy-to-use social media applications have proven successful in facilitating communication about CXR and quality assurance. In Cambodia, users provided positive feedback and appreciation and requested that the platform to be expanded to include more clinicians. In Myanmar, the Facebook group now has 44 members, including NTP staff who participated in the CXR interpretation TOT training, and is very active at providing support across the country.

LESSONS LEARNED

The assessment in Myanmar demonstrated that EQA systems for CXR interpretation in TB triage and diagnosis were feasible to assess and monitor quality and ultimately increase early TB diagnosis through better use of quality CXR and quality CXR interpretation.[12] This approach can provide EQA for CXR interpretation and be integrated as a routine NTP activity, similar to other EQA systems for laboratory examinations. One of the major challenges encountered was the limitation of resources, both human resources and adequate equipment, especially in hard-to-reach areas. CXR machines were not always available or functioning and readers were limited. When resources become available, the CXR EQA will be applied and expanded to all states and regions to help support the delivery of quality care in Myanmar. However, the initial design required several layers of experts with three different re-readers (i.e., district, regional and international) and was thought to be too resource intensive. The significant human resource burden was considered a barrier to full expansion as planned in the national strategic plan. The inclusion of external international readers in the approach was also determined to be unsustainable; thus, a simplified model with fewer levels of readers was ultimately adopted by the NTP of Myanmar. In the SOPs, the team articulated a less HR intensive model, as in Figure 1, which the NTP plans to implement soon. The NTP will integrate the CXR EQA SOP into the National TB laboratory EQA system, which is currently limited to sputum microscopy, but will expand further to other TB diagnostics. While EQA for CXR can be an important tool to assess and monitor quality and ultimately improve early TB diagnosis, it will not replace peer group discussion on CXR interpretation.

Investments to build the capacity of doctors, nurses and X-ray technicians in referral hospitals helps overcome the low specificity with significant inter-rater variation, which was the main limitation of CXR services in Cambodia. CXR training followed by systematic review of CXR films and online communication that allows feedback and advice from peers and experts improves clinicians' CXR interpretation knowledge and skills. This type of multi-faceted capacity-building intervention can help find missing people with TB and connect them to treatment. In both countries, it can help ensure that children, who more often rely on CXR for TB detection are accurately diagnosed. CTB teams recommend that this approach is further extended to include the private sector to help reach END TB goals.

Improving the quality of taking and interpreting CXR films in both Cambodia and Myanmar required only a moderate amount of investment. Human resources were the most important factor in the success of these programs. External trainers were contracted to help develop the training and lead the trainings of trainers. Of course, along with adequate HR, functioning CXR machines must be in place.

12. External Quality Assessment on Chest X-Ray Interpretation for TB Triage and Diagnosis: Feasibility Assessment Procedure. CTB Myanmar. May 2017

Lack of availability of CXR can be a major barrier in some parts of the world. Along with the machine itself, film, a technician to run it and electricity are all essential. In some places, referrals or strategic purchasing from private sector can augment a lack of public sector CXR facilities, but costs and convenience for the presumptive TB patient should be considered. In both countries, resources required for the electronic app platform were minimal as all providers had smart phones capable of taking and sending photos of CXR images. However, a dedicated core team to manage the app and provide timely responses is required to sustain efforts.

CONCLUSION

Recently, WHO has reconsidered Chest X-Ray (CXR) as a diagnostic tool that can be placed early in screening and triaging algorithms because of its high sensitivity, increased availability of radiography, and rapid results.[13] However, there are recognized challenges and limitations in the use of CXR, including low specificity, significant inter-rater variation, lack of trained staff, and limited access to quality and safe CXR equipment.[14] To overcome these limitations, there have been a number of advances in CXR technology such as electronically transmitting images, lower operating costs, improved portable systems and better image quality. Future inclusion of artificial intelligence for CXR reading can further expand the reach of CXR screening programs by reducing the burden on medical staff.

High burden countries have invested significant resources into improving laboratory diagnosis to help find the missing people with TB, however current laboratory options will not achieve TB elimination alone. Radiography has a place in both screening and diagnosis, but quality results need to be ensured. The innovative approaches undertaken by the national TB programs in Cambodia and Myanmar with the support of CTB will help both countries overcome the challenges in TB diagnosis and ensure more accurate results even in areas with difficult access. These strategies should be further expanded into other high burden settings in context where private sector providers are involved in TB services.

13. WHO. Chest radiography in TB detection – summary of current WHO recommendations and guidance on programmatic approaches, Geneva, 2016.
14. WHO. Tuberculosis prevalence surveys: handbook, Geneva, 2011.

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