Center For
Health Market Innovations

In partnership with: UNIVERSITY OF TORONTO

INNOVATIONS IN TUBERCULOSIS CARE: EXPLORING THE EVEDENCE BEHIND EMERGING PRACTICES IN LOW- AND MIDDLE-INCOME COUNTRIES

The Center for Health Market Innovations (CHMI; healthmarketinnovations.org) profiles close to 70 programs that engage in emerging practices of tuberculosis (TB) healthcare in low- and middle-income countries (LMICs).[i, ii] These programs use innovative delivery mechanisms and information communications technologies (ICTs) to improve access to TB diagnostic and treatment services, patient and provider adherence to care protocols, and affordability of healthcare for the poor. These approaches include integrating informal providers (IPs) into TB treatment programs and social franchises and using mobile phones for data collection and treatment surveillance. This analysis draws on data from the CHMI database and external evidence to provide an overview of emerging practices for improving TB healthcare with the goal of highlighting promising approaches and identifying knowledge gaps in the evidence base for future research.

Key Takeaways

- More than 45% of CHMI's TB programs are concentrated in East and West Africa and 97% are private, not-for-profit models.[ii]
- Emerging practices profiled by CHMI tend to focus on three major issues in TB care: correctly identifying individuals with TB, recruiting patients into TB treatment, and ensuring treatment compliance.
- Some programs are training IPs to offer TB services and improve access to diagnostics and treatment. Other programs are using mobile technologies to support TB surveillance and patient adherence to drug regiments.

Photo Top: The private sector plays a large role in TB treatment and ongoing care. This photo features Operation ASHA, a CHMI-profiled program with more than 200 DOTs treatment centers in India and Cambodia. Photo by Kieran Oudshoorn

> Evidence suggests that failure to involve all care providers used by TB suspects and patients hampers case detection, delays diagnosis, leads to inappropriate and incomplete treatment, contributes to increasing drug resistance and places an unnecessary financial burden on patients.
>
> – **The Global Fund to Fight AIDS, Tuberculosis and Malaria**

[i] *These are programs or policies – implemented by a wide variety of public and private actors –that have the potential to improve LMIC health systems where private providers tend to predominate and household out-of-pocket spending is a major source of health financing.*

[ii] *These figures represent data captured from the CHMI database on January 21, 2013 and may not be representative of the entire TB program landscape.*

Emerging Practices of TB Programs

While considerable progress has been made towards Millennium Development Goal targets for TB, the disease remains a major global health problem. There were an estimated 8.6 million new cases of infection and 1.3 million deaths from TB in 2012.[1] While treatment success rates remain high at 87% of all new cases, undetected cases and treatment coverage gaps threaten to hold back gains.[1] Gaps in TB detection and treatment contribute to increasing drug resistance and financial burden for patients.[2, 3] With the threat of multi-drug-resistant-TB and extensively drug-resistant TB, and the increased vulnerability of those with HIV to TB, both private and public sector efforts are needed to combat TB and improve health outcomes for the poor.[1, 4]

Understanding emerging practices, especially in the private sector, is critical for improving overall outcomes in TB. Research conducted by the TB Alliance and IMS Health found that in some countries the volume of TB drugs sold in the private sector is equal to or greater than that in the public sector.[5] Private market size has remained stable despite efforts by National Treatment Programs (NTPs) in many countries to increase their share of the TB treatment burden. In Western India, 86% of TB patients first consulted private practitioners, and 67% of the patients who seek private providers continued treatment in the private sector.[6] The private sector is also a major distribution channel for TB drugs–in India, Indonesia, Pakistan and the Philippines enough TB drugs are sold in their private sectors to treat all incident TB cases with a full TB drug regimen.[i]

Current concerns about private TB care provisions include inadequate diagnostic and treatment practices and lower treatment success rates. Private sector delivery of services and private sector support to NTPs must improve given the private sector's large role in TB care, concerns about private TB care provision involving inadequate diagnostic and treatment practices,[7] and lower treatment success rates.[8]

CHMI has documented close to 70 programs that work on TB in 33 countries, with approaches ranging from mobile phone apps that aid community health workers (CHWs) in TB diagnosis to programs that train IPs to improve TB case detection and treatment rates. Emerging practices profiled by CHMI tend to focus on three major issues in TB care: correctly identifying individuals with TB, recruiting patients into TB treatment, and ensuring treatment compliance. These components span the TB care continuum and address key points in a typical patient pathway. Engagement of programs across all three of these TB focus areas is prominent in TB drug shops and chains, many of which utilize a franchise model.

This analysis focuses on emerging practices of CHMI-documented TB programs, especially those that navigate challenges of access to TB diagnostic and treatment services, the timeliness and accuracy of TB control tools and processes, and patient and provider adherence to care protocols.

The CHMI database currently captures comparable data on over 1,200 programs in over 100 countries. The database documents programs that use innovative delivery and financing mechanisms to improve access, quality, or affordability of healthcare for the poor.[iii] Programs are tagged by the approach taken to improve health market performance: Organizing Delivery, Financing Care, Regulating Performance, Changing Behaviors, and Enhancing Processes. The graph on page 3 outlines the number of CHMI-profiled TB programs utilizing innovative delivery and financing mechanisms that fall within these categories. Approaches profiled in this brief were selected through a review of the mechanisms used by programs in the CHMI database and discussion in relevant gray literature.

The sections below examine some of the most notable emerging approaches and present the available supporting evidence—or lack thereof—about their effectiveness in improving the quality, affordability, and accessibility of TB services.

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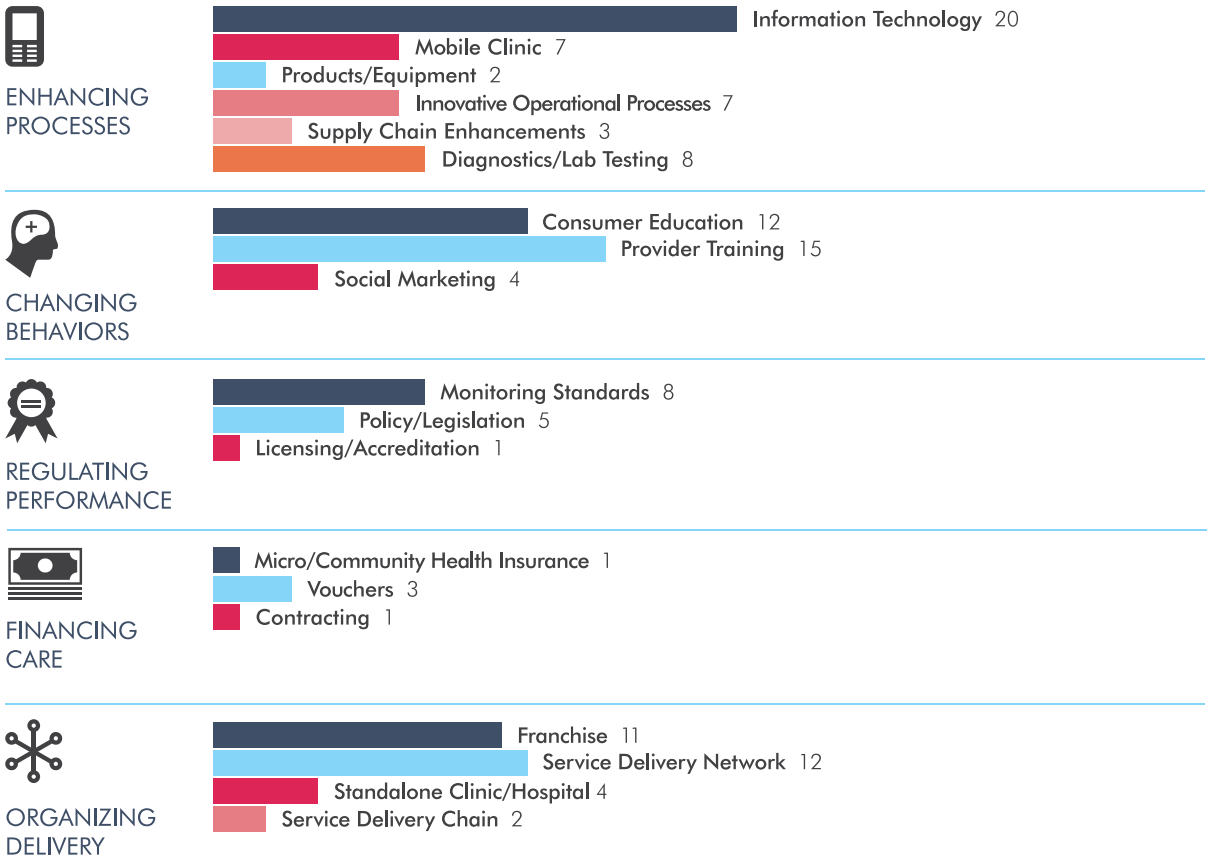
See Page 3 for Innovative TB Program Activities Graph »

[iii] CHMI data is obtained through systematic searches for innovative health programs led by in-country partners across 16 countries and global analytic partners in a broader set of countries. Direct searches are supplemented by literature reviews and self-reported information from programs. As a result, the data is limited to the information captured by contributions to the CHMI database and does not capture the full universe of in-scope programs.

Innovative TB Program Activites[iv, v]



Reported Results: Tracking Program Performance

While performance results for some programs have been externally verified, other programs are too small scale or resource-limited to undertake full evaluation studies. In order to capture the universe of program reporting, CHMI launched the Reported Results initiative to capture "what's working," or achieving the kind of health and financial protection results that are important to national and global health policymakers, donors, investors, and program implementers. Reported Results are clear and quantifiable self-reported statements of program performance related to health access, operations and delivery, and health status. For more information please visit: Bit.ly/CHMIReportedResults.

This report includes externally verified studies (under "The Evidence") and self-reported performance results to CHMI (under "Reporting Results").

[iv] *Programs may be tagged in more than one sub-category.*

[v] *This data is drawn from the CHMI database, downloaded on January 21, 2013 from http://healthmarketinnovations.org/*

Emerging Approaches to TB Care and Their Results

Many emerging approaches to TB healthcare delivery used by CHMI-profiled programs show promise, but research on their efficacy and results is limited. One emerging approach is the use of mobile technologies to strengthen TB surveillance and patient adherence to drug regimens, which is important for reducing person-to-person transmission of TB. Adherence to treatment programs is critical – the disease carries a high mortality rate if not treated, and breaks in regimen can lead to drug resistance.[9] Other programs in the CHMI database train IPs to offer TB services, as they are often the first point of contact for TB care.

Informal Providers: Partnering with Programs to Improve Access to TB Diagnostics and Treatment

Programs that train IPs to provide TB care have generally followed one of two formats: (1) training IPs to own and operate social franchises that offer TB services and (2) employing IPs as part of the health program. Engaging IPs to work with health programs and networks may contribute to the timely detection and treatment of TB patients and strengthen health systems. Further research is needed to assess the impact of such programs.[10]

The Evidence: Evidence on the effectiveness of IPs at delivering TB care and treatment is limited. A study of informal village doctors in Bangladesh, who had been trained to refer suspected TB cases for free diagnosis and to provide free Directly Observed Treatment, short-course (DOTS) to patients, found this approach effectively improved access to high quality, affordable TB care in poor rural areas.[11] In South Africa, training traditional healers on the management of TB and incorporating them as DOTS supervisors resulted in similar treatment completion rates and default rates compared to using nurses and CHWs as treatment supervisors.[12] These examples suggest that IPs can be a valuable resource when integrated into TB control programs.[13] In the social franchise model, IPs own and operate branded branches of health outlets with standardized services, with the goal of increasing access, care, quality, cost effectiveness, and equity.[14, 15] The Global Health Group reported that the number of social franchises offering TB diagnostic or treatment services more than tripled globally between 2008 and 2011, with most of these programs operating in Africa, Southeast Asia, and South Asia.[11]

Reporting Results: CHMI Currently Documents Five Programs Operating Under The Social Franchise Model

- **Sun Quality Health Franchise:** This franchise in Myanmar coordinates with the NTP for TB training and quality monitoring, adheres to NTP-approved treatment, provides case detection to the NTP, and makes referrals.[12, 16] The franchise has been noted for its ability to deliver highly subsidized, quality TB care and has achieved greater treatment success than the government-run program.[17] Their patients, who perceive the franchise as offering relatively affordable and attentive care,[18] are also slightly more likely to be in the lowest-income bracket, suggesting that social franchises owned by IPs can provide affordable TB care to the poor and increase health equity.

- **Operation ASHA:** Operation ASHA is a nonprofit organization working in India and Cambodia that establishes TB treatment centers at the doorsteps of the disadvantaged in existing community locales. They implement the DOTS program and install medicine pickup locations in clinics operated by IPs. Operation ASHA is currently serving 6.2 million disadvantaged TB patients. In rural areas, where patients are scattered, IPs carry out Mobile-DOTS, where the health worker visits the patient via motorcycle, bicycle, or boat. IPs conduct case detection, educate patients, and use eCompliance technology to ensure adherence of TB treatments. eCompliance is a low-cost biometric fingerprinting technology that identifies patients and tracks every dose taken to prevent default. As of 2014, Operation ASHA has 209 treatment centers in 19 cities across India and 56 in Cambodia. It has treated more than 39,000 patients and enrolled nearly 12,000 TB patients in 2013 alone. The average TB detection rate in areas where Operation ASHA works is 46% higher than the all-India average. The death rate for TB patients in South Delhi, in particular, has decreased from 6% to 2%. Operation ASHA has also achieved a cure rate of 87%, which is 2.7 times higher than the cure rate reported in a triangulation study by a WHO consultant in 2011 in the state of Chhattisgarh in India.[19]

- **World Health Partners (WHP):** World Health Partners operates a network of over 5,500 IP-owned rural social franchises, branded as the Sky network, in Bihar, India. The network provides TB services as part of their infectious disease coverage package. Rural IP social franchisees provide a broad range of primary care services, sell a variety of medications, facilitate telemedicine consultations with qualified doctors, and refer patients to nearby private and public sector clinics. A TB patient-tracking and adherence-monitoring system developed on the MOTECH platform allows for real-time patient management, includes web or voice-based treatment plus adherence reporting, and generates alerts and reminders for providers. Since 2012, the Sky network has identified over 5,100 new TB cases with over 2,800 patients placed on DOTS.[20] The project is now strengthening treatment uptake and adherence through closer engagement with patients and family members, reducing the dependence on providers alone. PAGE 5 »

Photo Above: A rural medical provider in India working through the social franchise World Health Partners. Photo by Meredith Kimball for CHMI

A TB health line is generating a large database of suspects, and a "family DOTS" approach is being piloted that allows WHP to directly interface with patients and family members through face-to-face and cell phone contact to increase detection and compliance.

- **Smiling Sun Franchise Program (SSFP):** The Smiling Sun Franchise network of Bangladesh is composed of 325 franchisee-owned clinics and 6,000 community service providers. The network provides a number of services in line with the National Tuberculosis Control Program, including DOTS treatment and microscopy services. Smiling Sun has achieved significant cost reductions for drugs: discounts have dropped from 16% to 25%, improving affordability for the poor.[21]

SMS: Utilizing Mobile Phones to Guide Health Workers and Patients in TB Treatment

Health workers are increasingly using mobile phones to enhance data collection and track TB patients. Health workers log basic patient data and send the information directly to a server, most commonly through SMS. The goal is to improve TB detection rates, since it is estimated that approximately one third of cases are undiagnosed and unreported.[1] At the same time, TB-positive patients are using mobile phones to ensure adherence to treatment. Mobile technology has the potential to streamline DOTS, with programs sending SMS reminders about medication to patients or requesting that patients send an SMS to their provider after taking medication. Other programs attach a sensor to medication containers that notify providers via SMS when opened,[22] or they require patients to send the codes revealed on urinalysis strips that test positive for medication.[23] Thirteen CHMI programs use SMS to collect data on TB patients and/or encourage adherence to TB treatment regimens.

The Evidence: There is currently little evidence available on the effectiveness of these interventions in TB,[17] and some question the appropriateness of this model as a replacement for person-to-person DOTS interventions.[24] However, SMS reminders for HIV-infected adults have been shown to improve antiretroviral therapy adherence[25] and rates of viral suppression[26] and to lower the likelihood of treatment interruption exceeding 48 hours.[27] Further study is needed to determine whether the rate of treatment success with this approach is comparable to that of face-to-face DOTS programs. In addition, studies should explore which SMS notification techniques are most effective in improving adherence to treatment, and the cost-effectiveness of such strategies should be evaluated.

Reporting Results: SMS Models that Report Results to CHMI Include:

- **On Cue Compliance:** Based in South Africa, On Cue Compliance uses specially designed pill bottles equipped with a SIM card and transmitter (known as SIMpill) to ensure TB drug adherence. When the pill bottle is opened, an SMS message is sent to a designated healthcare worker. If the pill bottle is not opened, the patient receives a reminder text message. The pilot demonstrated promising results: with SIMpill, 90% of patients complied with their medication regimen compared to the 22-60% compliance rate without the system.[36]

- **WelTel:** WelTel Kenya uses automated SMS messages to support TB and HIV medication adherence, using the widespread use and availability of mobile phones as a platform for improving health outcomes through mobile solutions. In a randomized trial carried out between May 2007 and October 2008, patients using WelTel's SMS system showed a 24% improvement in medication adherence and a 19% increase in suppressed viral loads compared to the control group.[28]

Mobile Phones: Improving the Supply Chain of Medications to Reduce Stock-Outs

Ensuring effective drug management and reliable drug supply is essential for high-quality TB treatment.[30] Stock-outs of TB medicines cause interrupted or delayed treatment, which can increase drug resistance and prolong illness.[7, 23] To counteract this, programs are using mobile technologies to collect information on drug use and stock, sending electronic messages to administrators when drugs need to be refilled.[17] Two CHMI programs use mobile technologies to monitor and manage stocks of TB medications.

The Evidence: There is little evidence regarding the success of mobile technology solutions for stock-outs in TB. Most evidence on this approach comes from malaria research, particularly involving a program called SMS for Life, which aims to reduce stock-outs in malaria treatment in the Tanzanian Public Health System using SMS, Internet, and mapping technology.[17] Studies have found that this approach decreases stock-outs compared to other areas not using this model.[31,32] More research is needed to determine whether this approach decreases stock-outs for TB medications and improves reporting efficiency. No programs using mobile technology solutions for stock-outs have reported results to CHMI, thus there are no "Reporting Results" for this topic.

Mobile Diagnostics: Increasing Diagnostic Efficiency Using Low-Cost Mobile Devices

Early, rapid, and accurate TB diagnosis is important for improving health outcomes, minimizing the spread of infection, and preventing additional suffering and expense.[1] Mobile technology is being used in novel ways to speed the diagnosis process and make it more accessible in areas outside of laboratories and health centers.[7] This often involves using applications and accessories with mobile phones that can turn them into diagnostic tools, such as a low-cost stethoscope made by attaching an eggcup to a mobile phone.[7] Phones can connect patients to specialists and lab technicians; for example, community health workers (CHWs) can take pictures of sputum smear slides or x-rays and send these images through their phones to diagnostic hubs. Results are sent back to the CHWs with minimal delay, and they are able to give a diagnosis to the patient in person, preventing unnecessary long-distance travel for diagnostic services.[7] There are two CHMI programs using mobile technology to diagnose TB.

The Evidence: One study examined the accuracy of sending images of Microscopic Observation Drug Susceptibility (MODS) cultures containing TB bacteria by mobile phone to a remote site for expert analysis.[33] The authors reported 99% agreement between readings of the mobile phone image and direct observation through a microscope. A study that developed a mobile-phone-mounted light microscope found that the resolution surpassed that necessary to assess TB sputum samples.[34] Greater research is needed on the feasibility of implementing these technologies and their accuracy in the field.

Evidence Gaps and Research Opportunities in TB

The effectiveness of innovative approaches is well documented for some programs. Programs that partner with IPs can not only be designed to fit into the broader context of a national TB program, but also appear to increase access, care, quality, cost effectiveness, and equity.[14, 15] Other innovative approaches, such as data collection using mobile devices, monitoring adherence through mobile technologies, using mobile technologies for drug supply management, and employing mobile phones as TB diagnostic tools, are promising but require further research.

> "Innovative activities may have even more potential when combined in mutually beneficial ways to increase efficiency, quality, and scale."

Innovative activities may have even more potential when combined in mutually beneficial ways to increase efficiency, quality, and scale. An example of one such approach in TB involves combining ICTs, service delivery networks, and provider training. ICTs can speed diagnosis and data collection, reduce the human resources required to observe medication adherence, and improve data quality by decreasing data entry errors. Provider training can increase quality by ensuring providers use the ICT correctly and are aware of TB guidelines for diagnosis and treatment. Service delivery networks connect and support providers by organizing delivery and expanding geographic access, which is needed to increase the scale of services. The combination of innovative activities may hold potential, but more research into these emerging approaches is needed in order to understand their ability to efficiently address TB on a large scale.

It is important to acknowledge interactions between national TB programs and private sector diagnosis and treatment programs.

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The ability to use mobile diagnostic technologies, for example, is largely affected by the requirements of NTPs. In the case of India, a patient must be diagnosed by a public sector lab in order to enroll in the government's free treatment program. Accordingly, improved coordination between public policy and private actors is critical; combining innovative activities will only work in the context of strong public-private engagement and coordination.

CHMI will continue to monitor, document, and report new information as it emerges, while identifying critical evidence gaps in order to establish TB research opportunities. This process is important for funders and governments who decide where to make investments in TB care. Going forward, CHMI will continue working with its partner organizations on the ground to identify more innovative health programs and with research institutions to explore evidence around such models. In doing so, CHMI hopes to showcase health programs that have the greatest potential to improve the success of innovative approaches for the poor.

The analysis was prepared by Onil Bhattacharya, Kathryn Mossman, and the T-HOPE team[v] at the University of Toronto, in collaboration with the Results for Development Institute.

Endnotes

1 World Health Organization (WHO) (2012) Global Tuberculosis Report 2012. Geneva: WHO.

2 World Health Organization (WHO) (2013) Ninth meeting of the Subgroup on Public-Private Mix for TB Care and Control and the Global Workshop on Engaging Large Hospitals: Meeting report. Bangkok: WHO. Available: http://www.who.int/tb/careproviders/ppm/NinthPPMreport.pdf?ua=1. Accessed 3 March 2014.

3 Tiermersma EW, van der Werf MJ, Borgdorff MW, Williams BG, Nagelkerke NJD (2001) Natural history of tuberculosis: duration and fatality of untreated pulmonary tuberculosis in HIV-negative patients: a systematic review. PLoS ONE 6(4): e17601.

4 World Health Organization (WHO) (2001) Involving private practitioners in tuberculosis control: issues, interventions, and emerging policy framework. Geneva: WHO.

5 Wells W, Ge CF, Patel N, Oh T, Gardiner E, et al. (2011) Size and usage patterns of private TB drug markets in the high burden countries. PLoS ONE 6(5): e18964.

6 Uplekar M, Juvekar S, Morankar S, Rangan S, Nunn P (1998) Tuberculosis patients and practitioners in private clinics in India. International Journal of Tuberculosis and Lung Disease 2: 324–329.

7 Singla N, Sharma PP, Singla R, Jain RC (1998) Survey of knowledge, attitudes and practices for tuberculosis among general practitioners in Delhi, India. International Journal of Tuberculosis and Lung Disease 2(5): 384-389.

8 Lönnroth K, Thuong LM, Lambregts K, Nhien T, Quy HT, et al. (2003) Private tuberculosis care provision associated with poor treatment outcome—a comparative cohort analysis of a semi-private chest clinic and the National Tuberculosis Control Programme in Ho Chi Minh City, Vietnam. International Journal of Tuberculosis and Lung Disease 7(2): 165–171.

9 mHealth Alliance, Stop TB Partnership (2012) Pushing the frontier: the role of mHealth in the fight against tuberculosis. Geneva: Stop TB Partnership.

10 Kobaru BB, Uplekar M, Lonnroth K (2011) Engaging informal providers in TB control: what is the potential in the implementation of the WHO Stop TB Strategy? A discussion paper. World Health & Population 12(4): 5-13.

11 Salim MAH, Uplekar M, Daru P, Aung M, Declercq D, et al. (2006) Turning liabilities into resources: informal village doctors and tuberculosis control in Bangladesh. Bulletin of the World Health Organization 84:479-484.

12 Colvin M, Gumede L, Grimwade K, Maher D, Wilkinson D (2003) Contribution of traditional healers to a rural tuberculosis control programme in Hlabisa, South Africa 7(9):S86-S91.

13 Newell JN, Pande SB, Baral SC, Bam DS, Malla P (2004) Control of tuberculosis in an urban setting in Nepal: public-private partnership. Bulletin of the World Health Organization 82: 92–98.

14 Schlein K, Montagu D (2012) Clinical social franchising compendium: an annual survey of programs, 2012. San Francisco: Global Health Group.

15 Population Services International (PSI) (2012) Social franchising for TB care & control. PPM subgroup meeting, Kuala Lumpur, Malaysia, 11 November. Kuala Lumpur: PSI.

16 World Health Organization (WHO) (2010) Public-private mix for TB care and control: a toolkit. Geneva: WHO.

17 Lönnroth K, Aung T, Maung W, Kluge H, Uplekar M (2007) Social franchising of TB care through private GPs in Myanmar: an assessment of treatment results, access, equity and financial protection. Health Policy and Planning 22: 156–166. Available: http://www.ncbi.nlm.nih.gov/pubmed/17434870. Accessed 10 March 2013.

[v] *The team at T-HOPE includes: Bhattacharya O, McGahan A, Mitchell W, Mossman K, Hayden L, Ginther J, Sohal R, MacDonald JA, Parikh H, Shahin I.*

18 O'Connell K, Hom M, Aung T, Theuss M, Huntington D (2011) Using and joining a franchised private sector provider network in Myanmar. PloS ONE 6: e28364. Available: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=3236746&tool=pmcentrez&rendertype=abstract. Accessed 10 March 2013.

19 Center for Health Market Innovations (CHMI) (2013) Operation ASHA. Available: http://healthmarketinnovations.org/program/operation-asha. Accessed 8 August 2013.

20 World Health Partners (2014). Available: http://www.worldhealthpartners.org/?p=26. Accessed 1 May 2014.

21 Center for Health Market Innovations (CHMI) (2014) Smiling Sun Franchise Program. Available: http://healthmarketinnovations.org/program/smiling-sun-franchise-program-ssfp. Accessed 3 March 2014

22 Interactive Research and Development, Stop TB Partnership (2012) mHealth to improve TB care. Geneva: Stop TB Partnership.

23 Sandhu J (2011) Opportunities in mobile health. Stanford Social Innovation Review Fall: 14–17.

24 Barclay E (2009) Text messages could hasten tuberculosis drug compliance. Lancet 373: 15–16.

25 Da Costa TM, Barbosa BJP, Sigulem D, De Fatima Marin H, Pisa I (2012) Results of a randomized controlled trial to assess the effects of a mobile SMS-based intervention on treatment adherence in HIV/AIDS-infected Brazilian women and impressions and satisfaction with respect to incoming messages. International Journal of Medical Informatics 81: 257–269.

26 Lester RT, Ritvo P, Mills EJ, Kariri A, Karana S (2010) Effects of a mobile phone short message service on antiretroviral treatment adherence in Kenya (WelTel Kenya1): A randomized trial. Lancet 376: 1838–1845.

27 Pop-Eleches C, Thirumurthy H, Habyarimana JP, Zivin JG, Goldstein MP et al. (2011) Mobile phone technologies improve adherence to antiretroviral treatment in a resource-limited setting: a randomized controlled trial of text message reminders. AIDS 25: 825–834. Available: http://www.ncbi.nlm.nih.gov/pubmed/21252632. Accessed 10 March 2013.

28 Center for Health Market Innovations (CHMI (2013) On Cue Compliance. Available: http://healthmarketinnovations.org/program/cue-compliance. Accessed 8 August 2013.

29 Center for Health Market Innovations (CHMI) (2013) Weltel. Available: http://healthmarketinnovations.org/program/weltel. Accessed 8 August 2013.

30 Fitzpatrick C, Floyd K, Baena IG, Glaziou P, Sismanidis C (2010) The global plan to stop TB 2011-2015: transforming the fight towards elimination of tuberculosis. Geneva: Stop TB Partnership.

31 Barrington J, Wereko-Brobby O, Ward P, Mwafongo W, Kungulwe S (2010) SMS for Life: a pilot project to improve anti-malarial drug supply management in rural Tanzania using standard technology. Malaria Journal 9: 298. Available: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2978233&tool=pmcentrez&rendertype=abstract. Accessed 6 March 2013.

32 Githinji S, Kigen S, Memusi D, Nyandigisi A, Mbithi AM (2013) Reducing stock-outs of life saving malaria commodities using mobile phone text-messaging: SMS for Life study in Kenya. PLoS ONE 8: e54066.

33 Zimic M, Coronel J, Gilman RH, Giannina C, Curioso WH, et al. (2009) Can the power of mobile phones be used to improve tuberculosis diagnosis in developing countries? Transactions of the Royal Society of Tropical Medicine and Hygiene 103: 638–640. doi:10.1016/j.trstmh.2008.10.015.

34 Breslauer DN, Maamari RN, Switz N a, Lam W a, Fletcher D a (2009) Mobile phone based clinical microscopy for global health applications. PloS ONE 4: e6320.