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Opportunities for Community Health Workers to Contribute to Global Efforts to End Tuberculosis

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Abstract

Tuberculosis (TB) has emerged as the leading infectious cause of death globally. New paradigms are needed to reduce TB rates and mortality. Programs harnessing the potential of community health workers (CHWs) to enhance TB prevention and care have shown great promise. In this perspective article, we review the history of CHW-based efforts to prevent and treat TB, present evidence illustrating the effectiveness of CHWs across the entire cascade of TB care, and outline additional opportunities for CHWs to address challenges particular to the TB pandemic. Despite many promising studies, knowledge gaps persist and we suggest an agenda for future research on the role of CHWs in TB prevention and care.

Keywords

Community Health Workers; Tuberculosis; Global Health; Health Care Delivery; HIV

Introduction

Approximately one-quarter of humans are infected with *Mycobacterium tuberculosis* (*Mtb*). In 2017, an estimated 10 million individuals developed active disease and an estimated 1.3 million people died, making *Mtb* the most lethal infectious organism on the planet (World Health Organization, 2018). New paradigms are needed to reduce TB rates and mortality including more organized and extensive use of Community Health Care Workers (CHWs).

CHWs can be defined as individuals who lack formal medical or nursing education, but have received focused clinical training to serve as extensions of existing health systems by conducting specific diagnostic, preventative, referral, and treatment tasks within or close to their communities on a volunteer or paid basis. CHWs are becoming integral components of health systems globally (Perry, Zulliger, & Rogers, 2014). Specific to the TB pandemic, CHWs have opportunities to contribute to TB prevention and to improve TB care across the entire continuum of care on both individual and community levels.

A brief history of community-based tuberculosis prevention and care efforts

Shortly after anti-mycobacterial therapy was introduced in the 1950s, it became clear that sanatorium-based care was ill-suited for TB treatment, particularly for underserved patients in impoverished counties (McMillen, 2015). Sanatoria could not accommodate the large number of patients who needed 18 months of therapy. For instance, there were only 23,000 beds for an estimated 2.5 million TB patients in India. Inadequate outpatient care systems resulted in many patients not initiating or completing therapy. In 1959, a landmark Indian study showed that home-based therapy for TB was feasible and successful with teams that included CHWs. (Tuberculosis Chemotherapy Centre, 1959). The CHWs had closer contact with the patients than physicians and nurses and played an important role in treatment support and health education. Treatment at home was less disruptive to family life and allowed quicker resumption of work than treatment in sanatoria. In the 1960s-1980s, outpatient therapy with CHWs was implemented successfully in several other countries (McMillen, 2015).

Based on Karel Styblo's work in Tanzania in the 1980s, the World Health Organization (WHO) attempted to standardize systems and therapy for TB treatment in 1990 through the Directly Observed Treatment Short course (DOTS) program, which allowed for decentralized therapy but required directly observed therapy by healthcare workers, or CHWs, for at least the first two months of therapy (Hopewell, 2002). Soon thereafter, community-based DOTS (CB-DOTS) was instituted. This program relied on CHWs to provide TB services in settings where patients lived and worked. CB-DOTS relieved pressure on overburdened health facilities and made treatment more feasible and convenient for patients, particularly those living in remote locations (Wilkinson, 1997). But major gaps in full dissemination and implementation remained.

Even as community-based TB treatment was being implemented globally, treatment of multidrug-resistant TB (MDR-TB) presented a new challenge. MDR-TB therapy was initially limited to hospitals due to concerns about severity of illness, complicated regimens, suboptimal outpatient treatment, and lack of well-developed infrastructure to support complex and prolonged community-based care. But the prohibitive cost of hospital care in low and middle-income countries (LMIC) created urgency to establish robust infrastructure and systems for community-based MDR-TB treatment (Nicholson, Admay, Shakow, & Keshavjee, 2016). In the late 1990s, Socios en Salud, a Peruvian NGO, used a CHW-based program to achieve an 83% cure rate in the community. CHWs helped to provide necessary medications, social support, and nutrition (Mitnick et al., 2003). Contemporaneously, a national outpatient MDR-TB treatment program in Peru reported a cure rate of 48% (Suarez et al., 2002). In 1998, the WHO introduced the DOTS-plus strategy, which included community-based approaches to treat MDR-TB and enhance HIV/TB care integration (Iseman, 1998).

The STOP-TB initiative (2006-2015) emphasized, for the first time, the need to "empower people with TB, and communities (World Health Organization, 2008a)." Community-based efforts were closely studied and recommendations were made to integrate them with national

policies. CHWs have since occupied an integral role in the aspirational End-TB (2015-2035) effort, reaffirmed at a WHO meeting in Addis-Ababa in November 2015. TB survivors were recognized to have an important role as community-based advocates locally and nationally (World Health Organization, 2015).

Despite their successes and WHO endorsement, there remains ongoing skepticism about the capacity of CHWs to contribute to global TB efforts.

Opportunities for CHW-based interventions in TB prevention and care

CHWs have made documented contributions throughout the TB cascade of care, namely: case detection, linkage to care, treatment support, ensuring treatment success, and prevention (Fig. 1).

1. Improved case detection

Many examples support the view that CHWs can positively impact TB case detection rates in communities.

A large Ethiopian study trained 1024 CHWs, through a 5-day workshop. These CHWs identified 216,165 individuals with TB symptoms between 2010 and 2015 (Datiko et al., 2017). Of those identified by the CHWs, 12% had confirmed TB disease. Furthermore, CHWs doubled the case-notification rate (CNR) for smear-positive TB and increased CNR more than 1.5-fold for all forms of TB. Comparatively, there were no changes in the CNR of the control regions.

In the DETECTB study (2006-2008) from Zimbabwe, CHWs used a door-to-door strategy to significantly increase the case detection rate from 287/100,000 to 380/100,000. Providing a mobile van to CHWs further increased the rate to 420/100,000 (Corbett et al.).

A South African study (2010-2012) demonstrated that integrated teams of nurses, health educators, and HIV counselors could efficiently identify TB patients through targeted congregate screenings at taxi ranks, municipality events, home-based care events, pension pay points, and prisons (Shenoi et al., 2017). CHWs used a TB symptom screen and then collected sputum samples to detect individuals with microscopically confirmed drug-susceptible and drug-resistant TB, resulting in a CNR of 730 per 100,000 (number needed to screen (NNS): 137). Extensively drug-resistant (XDR)-TB or MDR-TB was found in 28.6% of those with active disease, indicating that CHWs can be trained to successfully detect overlooked individuals in community settings capable of transmitting both susceptible and drug-resistant TB.

ZAMSTAR, a large randomized trial conducted between 2006 and 2009, compared the impact of community-based enhanced TB case finding and household interventions using CHWs in Zambia and South Africa (Ayles et al., 2013). The trial failed to show statistically significant decreases in TB prevalence and transmission, but there was a trend towards benefit in the household intervention group and a non-significant trend towards decreased TB incidence among children from homes receiving household-level interventions.

In Bangladesh, CHWs, called *shebikas*, working for an NGO called Building Resources Across Communities (BRAC), helped increase the rates of smear-positive TB detection from 7.1% to 11.2% ($p<0.001$) between 2005 and 2010 (S. Islam et al., 2013).

In the South Kivu province of the Democratic Republic of the Congo where military conflict has disrupted health infrastructure, former TB patients, trained in 3-day workshops, were able to screen 650,434 individuals for TB with a NNS of 151 at a low cost of $44 per person diagnosed (André et al., 2018).

A modeling study from South Africa has further demonstrated that CHWs can be capacitated to conduct cost-effective community-based HIV and TB case detection with a threshold of $6,618 per life year saved (Gilbert et al., 2016). The approach of annual or twice-yearly screening for HIV and TB by CHWs coupled with Isoniazid Preventive Therapy (IPT) for 12 or 36 months cost less and was more effective than the status quo of individuals with TB and/or HIV symptoms self-presenting to healthcare facilities.

Thus, CHW programs can be efficient and cost-effective interventions to enhance case detection, especially for remotely located populations. With advances such as GeneXpert Omni that allow for portable cartridge-based nucleic acid amplification testing, CHWs could feasibly bring point-of-care TB testing to the doorstep of community members (Drain & Garrett, 2015).

2. Improved linkage to care

Delayed diagnosis and treatment of TB increases the risk of disease progression, transmission, preventable hospital admissions, and death (McMillen, 2015; World Health Organization, 2018). This important step in the care cascade is often problematic. CHWs can potentially obviate the need to travel long distances, decrease diagnostic delays, and quickly connect patients to the health system. For instance, in Bangladesh, not only did CHWs collect specimens from individuals, they also communicated with the laboratories and physicians to initiate therapy (M. A. Islam, Wakai, Ishikawa, Chowdhury, & Vaughan, 2002).

In India, where 18% of sputum-positive patients fail to initiate therapy, Operation ASHA (OpASHA) equips CHWs with digital screening algorithms on computers so individuals who screen positive are immediately linked to an integrated team of providers. Through its integrated system, OpASHA ensures that all sputum-positive patients initiate therapy (Operation ASHA, 2016a).

Thus, by increasing disease awareness, enhancing referrals, and by making TB screening and treatment available within the community, CHWs can enhance linkage to care and contribute to the goal of TB elimination. However, more research is necessary to study the role of CHWs in improving linkage to care in a diverse range of settings and countries.

3. Improved treatment support

Patients need support and supervision as they take multiple pills daily and potentially experience adverse effects over months of treatment. TB programs have struggled with

lapses in adherence and high rates of disengagement from care (McMillen, 2015). CHWs are well positioned to provide patient education, support adherence, and reduce disengagement during prolonged treatment courses.

In the 1980s, Partners in Health (PIH) introduced the use of CHWs called accompagnateurs, with basic literacy and brief training, to support Haitian patients through their TB treatment. A bundle of financial incentives, nutritional support, and aggressive home follow up by accompagnateurs increased treatment adherence and completion and cure in all participating patients (Farmer, Robin, Ramilus, & Kim, 1991). PIH has successfully scaled up similar CHW programs internationally for both TB and HIV (Palazuelos, Farmer, & Mukherjee, 2018).

In Bangladesh, BRAC instituted a model whereby patients deposited a small sum at the initiation of therapy that was shared with CHWs upon completion. The rates of disengagement fell to 3.1% (Chowdhury, Chowdhury, Islam, Islam, & Vaughan, 1997). Similarly, Ethiopian CHWs drove down disengagement from care in their regions significantly from 21% to 3% within 4.5 years (Datiko et al., 2017).

In India, OpASHA pioneered the use of e-compliance, an inexpensive technology that involves a laptop computer, biometric scanner, and online software that records fingerprints or retinal scans of both patients and CHWs to document the daily consumption of TB medications. Missed doses create alerts that prompt home visits from CHW teams that provide patients with medications and counseling. OpASHA has achieved a low disengagement from care rate of 4% compared to an estimated 20% in India contemporaneously. Additionally, with the support of OpASHA's CHWs, more than 85% of patients in the program completed treatment (Operation ASHA, 2016b).

Thus, CHWs can be effective in successfully supporting patients through the required prolonged and challenging TB treatment course.

4. Improved treatment success

Treatment success is defined as treatment completion and cure. There are numerous examples in which CHWs have been able to improve rates of treatment success.

Bangladesh's TB cure rate was approximately 50% in 1990. The BRAC CHW program helped increase cure rates to approximately 85% by 1997 (M. A. Islam et al., 2002). More recently, a CHW-based intervention in Ethiopia (2010-2015) increased treatment success rates from 76 to 95% within five years (Datiko et al., 2017).

Due to its success in India, OpASHA's e-compliance was also implemented in the Millennium Village Project in Uganda. Patients treated using e-compliance had a three-fold higher cure rate than those who did not. Also, there were non-significant decreases in mortality and disengagement from care (Slagle, Ben Youssef, Calonge, & Ben Amor, 2014). The success of e-compliance in Uganda demonstrated the transferability of this sophisticated platform across countries.

A recent systematic review found that CB-DOTS had improved rates of treatment completion and cure as well as decreased mortality compared to clinic-based DOTS (Zhang, Ehiri, Yang, Tang, & Li, 2016).

Compared to treatment provided by facilities, CHW-based programs in high burden countries such as Brazil, South Africa, Ethiopia, Malawi, and Uganda were able to reduce treatment costs by 40-74% (Vaughan, Kok, Witter, & Dieleman, 2015). In a South African study (1998-1999), patients were given the option to have a paid treatment supporter at home or workplace-based supervision or traditional clinic-based treatment. Community-based care was found to be more than twice as cost-effective as clinic-based care for drug-sensitive TB. The costs were $392 vs. $1302 per patient successfully treated for new patients, and $766 vs. $2008 for patients receiving retreatment (Sinanovic et al., 2003).

A study from Bangladesh found that that BRAC's CHW program spent $64 per person cured whereas the government program-- which utilized a clinic-based model -- spent $96 per person cured in 1996-1997. Patients enrolled in CHW programs had less loss of income and lower treatment-related costs(M. A. Islam et al., 2002).

Thus, CHW-based programs in diverse settings have improved rates of treatment success with evidence of cost-effectiveness.

Additional areas for CHWs in TB care

Addressing Drug resistance:

Early diagnosis and treatment support for drug-resistant TB is crucial. In 2008, Peruvian CHWs facilitated outpatient XDR-TB therapy for 48 HIV-negative patients. The patients required minimal hospitalization over an eighteen-month course of therapy and 60% achieved treatment success (Mitnick et al., 2008).

In South Africa, CHWs, trained to support patients through lengthy treatments and monitor for adverse effects, have been essential in decentralizing MDR-TB treatment from specialty hospitals to the outpatient and home-based setting (Brust et al., 2012). A large study conducted between 2008-2010 showed that community-based care for MDR-TB patients was more effective than care in central, specialized TB hospitals with improved odds of a successful treatment outcome (OR: 1.43; p=0.01). However, outcomes varied substantially among community sites, related to quality of implementation (Loveday et al., 2015). A systematic review from 2016 surveyed CHW programs in 27 high-burden countries and concluded that CHW-based programs for MDR-TB and XDR-TB had a significantly higher treatment success rate than traditional hospitalization (Williams, Makinde, & Ojo, 2016).

Thus, there is a clear need for national and local TB programs to study and implement CHW-based care models for drug-resistant TB across the care cascade.

The HIV/TB syndemic:

People living with HIV (PLHIV) constitute 9% of global TB cases (World Health Organization, 2018). In PLHIV with active TB disease, outcomes are improved with integrated care (Abdool Karim et al., 2010; El-Sadr & Tsiouris, 2008).

HIV testing and treatment is crucial for all TB patients. However, only 60% of notified TB patients had a documented HIV test in 2017 (World Health Organization, 2018). CHWs working in integrated teams with nurses can efficiently identify individuals with both HIV and TB through community-based congregate screenings (Shenoi, 2017). In Uganda, a five-day community-based health screening campaign was able to provide integrated screening services that was successful in detecting undiagnosed HIV and TB among community members and linking them to care (Chamie et al., 2012). Teams of CHWs conducting integrated household screenings for HIV, TB, and non-communicable diseases (NCDs) were able to reach community members in remote South African communities who had TB symptoms and link them to care. Of the individuals with TB symptoms, 10% were known to be HIV positive (Bunda, 2016). Many were not on antiretroviral therapy and were not accessing healthcare. CHWs conducting TB contact investigation in Uganda were able to also provide HIV counseling and testing (Ochom et al., 2018). There was 99.1% agreement between HIV testing done by CHWs and the laboratory technicians. CHWs reported the HIV test results and linked patients who tested positive to clinics for care. Finally, integrating a symptom-based TB screening questionnaire into extant HIV screening efforts can improve TB case finding without adding burdens or costs to HIV screening efforts (Gilbert et al., 2016; Howard & El-Sadr, 2010).

Thus, well-trained and supervised CHWs with good case-management protocols can support the integration of HIV/TB services.

TB Prevention:

CHWs can have an important role in TB prevention, as well as care. This is particularly clear in supporting IPT, especially among those with latent TB infection (LTBI) and HIV co-infection. The WHO recommends IPT for all PLHIV because of high rates of TB reactivation (Selwyn et al., 1989; World Health Organization, 2008b). IPT has been shown to reduce the risk of TB disease and mortality among individuals coinfected with HIV and TB and is a critical component of the End-TB strategy (Akolo, Adetifa, Shepperd, & Volmnik, 2010; TEMPRANO Study Group, 2015) with a survival benefit independent of antiretroviral therapy. Nevertheless, IPT program uptake has been disappointing globally (McMillen, 2015).

CHW programs can make IPT a routine part of HIV care-bundles, collect data, and counsel patients regarding its importance. For instance, in 2004, PLHIV serving as lay counselors to goldmine workers in the Free State, South Africa successfully initiated IPT among 82% of the eligible individuals (Charalambous et al., 2004). In KwaZulu-Natal, CHWs trained to do multi-disease screenings were able to find and refer HIV patients overlooked for IPT (Norton et al., 2017).

Co-morbid non-communicable chronic diseases (NCDs):

NCDs like diabetes mellitus (DM), smoking, and alcoholism increase the risk of TB disease and could jeopardize the success of the End-TB strategy (Sinha, Moll, Brooks, Deng & Shenoi, 2018). DM is a particularly serious concern as it increases the risk of developing active TB by approximately three times, almost quadruples risk of relapse, and doubles the mortality (Baker et al., 2011; Jeon & Murray, 2008). The WHO has stressed high quality DM care for patients with TB (World Health Organization, 2011).

CHWs can help integrate TB/DM care by screening community members for both diseases. For instance, South African CHWs involved in household-level TB and HIV screening were also able to screen for DM and hypertension and make necessary referrals (Bunda, 2016). Similarly, integrated community screenings in Uganda that successfully screened community members with undiagnosed HIV and TB also identified individuals with undiagnosed DM and linked them to care (Chamie et al., 2012). A systematic review of sixteen studies demonstrated that implementing CHW programs for the prevention and treatment of tobacco cessation, diabetes control, and hypertension can be more effective than standard therapy. However, the evidence for the different conditions varied in quality and additional research is necessary (Jeet, Thakur, Prinja, & Singh, 2017).

Providing services for NCDs in addition to those for HIV/TB could provide efficient and holistic care to patients. Furthermore, patients may also be more welcoming of a CHW known to provide multiple different types of care and not just HIV/TB services, thus de-stigmatizing the visit and maintaining confidentiality.

Broadening the scope of practice does carry the risk of decreasing the quality of care for specific diseases, but such holistic care would actualize the END-TB strategy's aspirations of patient-centeredness. Ensuring appropriate and ongoing supervision, working with local partners to determine scope, and maintaining vigilance about the quality of care is critical (Hill et al., 2014). CHWs can at least be trained to refer TB patients with non-communicable co-morbidities to regional primary care clinics.

Need for future research:

Although we have illustrated many promising studies that support CHW programs, research on the feasibility, acceptability and effectiveness of CHW programs remains scanty and large knowledge gaps persist (Christopher, Le May, Lewin, & Ross, 2011; Frymus, Kok, De Koning, & Quain, 2013). While numerous studies have evaluated implementation of CHW programs, few have been theory-based or utilized implementation frameworks (Allen, Barbero, Shantharam, & Moeti, 2018). The First International Symposium on Community Health Workers, held in Kampala in February 2017, concluded with a call for mixed-method research that explored the role of CHWs in priority health problems that included communicable, non-communicable, and maternal-child diseases while paying attention to factors important in programmatic success and sustainability and considering the relationship between CHWs and professional cadres of health workers (Maher, 2017).

We need well-designed implementation research, modeling studies, and health policy research to successfully operationalize CHW programs, integrate them into existing health systems, and make them scalable. In Table 1, under the acronym “STRIDES,” we have suggested some research priorities to improve selection and retention, training and supervision, reputation and perception, integration into health systems, and diversity of services while also evaluating the effectiveness and sustainability of CHW programs.

Conclusion:

CHWs can provide the health care system with a recognizable face, providing community members with the familiarity, sensitivity, skills, and compassion that they need as they grapple with TB while also improving efficiency and reducing costs. However, no one size fits all. CHW programs must be tailored to different contexts based on geography, resource levels, characteristics of the existing healthcare system, and TB prevalence. Here, we have presented general functions and principles that are widely applicable and have presented examples of successful programs.

Despite their decades of documented successes, CHWs are still considered ancillary services, not agents of health care transformation. CHWs need to be recognized as valuable and legitimate members of the care team. Their efforts, at times putting their own health at risk, must receive appropriate recognition and remuneration. Additionally, the legal and professional restrictions on the scope of practice for CHWs must be liberalized. While research will strengthen the rationale for CHW programs, advocacy will also be necessary to ensure widespread implementation.

With good training, adequate remuneration, careful supervision, opportunities for self-determination, community engagement, sufficient resources, unwavering political support, and close integration with the formal health system, CHW-based programs should contribute substantially in our endeavors to end the global TB epidemic.

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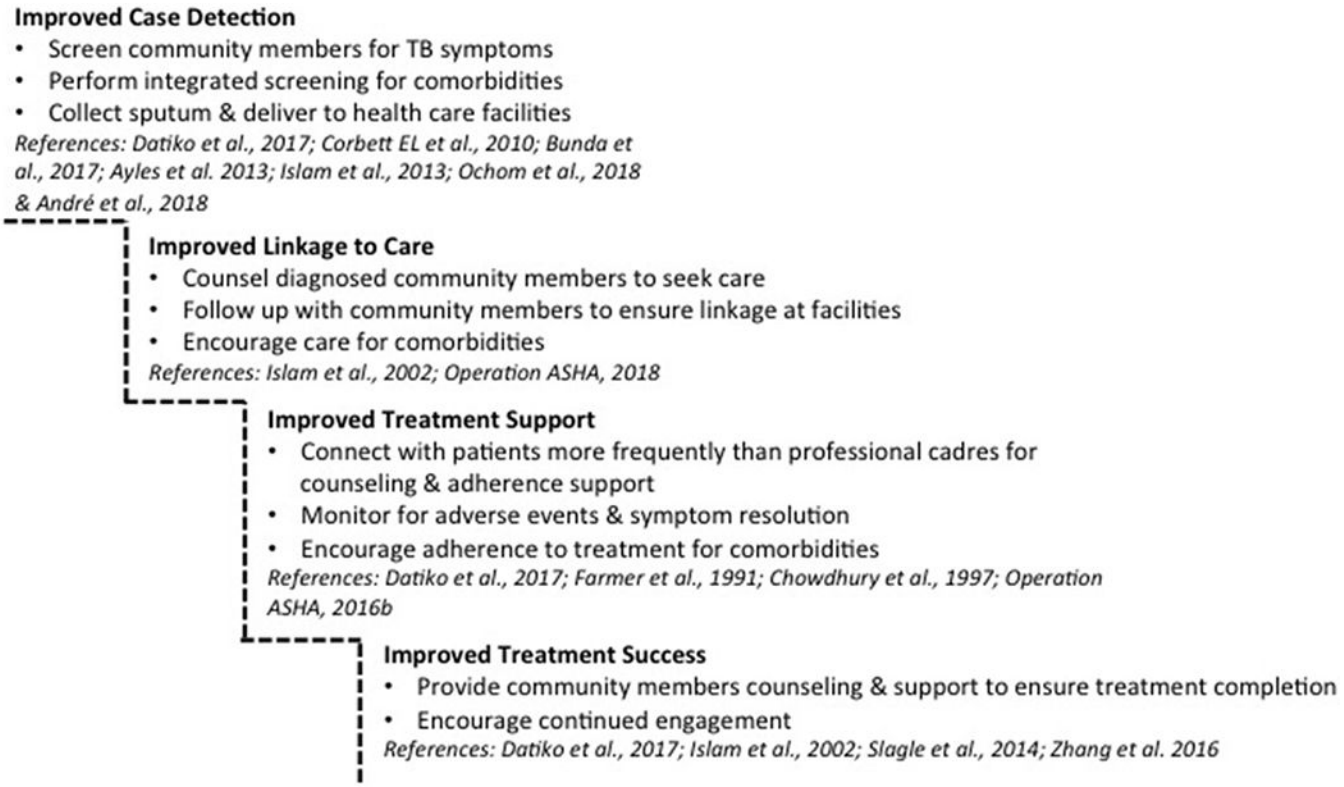

Figure 1.

Community health workers (CHWs) can contribute at every step of the cascade of care for individuals with TB disease.

Table 1:

Research priorities for Community Health Worker (CHW)-based programs. (TB: tuberculosis; CHW: community health worker; HIV: human immunodeficiency virus)

Selection and retention	Implementation research is needed to determine best practices for selection of suitable candidates for CHW training. High turnover rates in CHW programs need attention. Determining means to improve retention such as financial incentives and improved pay is necessary.
Training and Supervision	Pedagogical research can help develop best practices for initial and ongoing education of CHWs. Research is also needed to determine optimal levels and strategies of supervision required for various tasks.
Reputation and perception	Qualitative research is necessary to understand what makes CHWs acceptable and valuable to community members and the barriers and facilitators to successful collaboration with other health care workers.
Integration into health systems	Implementation research and modelling studies are necessary to identify tasks CHWs can perform efficiently and reliably, thereby freeing nurses and physicians to perform more technically sophisticated tasks with acceptance by hierarchical professional structures. Studies on best strategies for integration of TB, HIV and NCDs are needed. Health policy and systems research can help inform the integration of CHWs into existing health care infrastructure. Solutions may vary in different settings, countries, and systems.
Diversifying services	Needs assessments are vital to identifying the services most needed and preferred by community members. Implementation research is necessary to determine optimal scope of practice. Such research can help address legal and administrative restrictions on scope of practice.
Effectiveness	Further demonstration of CHW effectiveness in some segments of the TB cascade of care such as linkage to care is needed. Comparative effectiveness studies are needed to assess the impact of other strategies such as point-of-care tests and mHealth tools. Additionally, dissemination and implementation research is necessary to identify the characteristics of successful CHW programs which can inform design and scale-up of future programs.
Sustainability:	Additional cost-effectiveness and health policy research is necessary to support long term investment in CHW interventions. Financing mechanisms will also need to be explored, implemented, and evaluated on a global and country-specific level. Dissemination and implementation research is needed to study how best to scale-up CHW programs and ensure long term stability and modelling studies to forecast long term impact.