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Community-based treatment of multidrug-resistant tuberculosis in Lima, Peru: 7 years of experience

Sonya Shin[a,b,*], Jennifer Furin[a,b], Jaime Bayona[b], Kedar Mate[c], Jim Yong Kim[a,c], Paul Farmer[a,c]

[a] *Division of Social Medicine and Health Inequalities, Brigham and Women's Hospital, 1620 Tremont St 3rd floor, Boston, MA 02120-1613, USA*

[b] *Socios en Salud, Lima, Peru*

[c] *Department of Social Medicine, Harvard Medical School, Boston, MA 02115, USA*

Abstract

Programs implementing community-based directly observed therapy (DOT) have demonstrated success in the treatment of patients with tuberculosis. However, given complexities in the management and treatment of patients infected with multidrug-resistant tuberculosis (MDR-TB), the utilization of community-based DOT to treat MDR-TB patients has only recently been successfully attempted. We describe the first such program and highlight the crucial components and most critical challenges to creating a successful community-based MDR-TB treatment program.

Keywords: Tuberculosis; Community-based treatment; Non-governmental organizations; Directly observed therapy; Multidrug-resistance; Peru

Introduction

Tuberculosis (TB) remains one of the leading infectious killers of adults globally; an estimated one-third of the world's population is infected *Mycobacterium tuberculosis*. Directly observed therapy (DOT) has been a central component of TB treatment for at least 30 years (Fox, 1983). Many successful DOT programs are based on collaborations between community-based organizations and Ministry of Health programs (Kironde & Klaasen, 2002; Mangura et al., 2002; Hurtig et al., 2002; Maher, Gorkom, Gondrie, & Raviglione, 1999). Widespread implementation of DOT in resource-poor settings has been shown to be cost-effective in bringing about improved patient outcomes (Floyd, Wilkinson, & Gilks, 1997; Chaulk, Moore-Rice, Rizzo, & Chaisson, 1995; Weis et al., 1993).

Drug-resistant TB is a growing problem throughout the world (Pablos-Mendez et al., 1998). Multidrug-resistant tuberculosis (MDR-TB) is defined as strains of TB resistant to the two most powerful antituberculous medications, isoniazid, and rifampin (Iseman & Goble, 1996). MDR-TB is more difficult to treat than its fully susceptible counterpart, often requiring 18–24 months of therapy with four to eight different medications, including daily injection for at least 6 months (Farmer, Furin, & Shin, 2000). Faced with rising rates of MDR-TB, many communities must now shift their focus from solely prevention of drug-resistant strains to the treatment of patients with active MDR-TB (World Health Organization, 2000). Strategies to both prevent and treat MDR-TB must be integrated into pre-existing TB control programs. Currently, standard of care for patients with MDR-TB includes DOT; however, until recently, DOT of MDR-TB treatment was carried out in the hospital setting, given complexities of the drug dosing and toxicities (Iseman, Madsen, Goble, & Pomerantz, 1990; Tahaoğlu et al., 2001).

In 1996, an initiative to treat patients with MDR-TB was established in Lima, Peru through a collaborative effort among several community-based NGOs (Socios En Salud, Lima; Partners in Health, Boston), a

*Corresponding author. Tel.: +1-617-732-6438; fax: +1-617-525-7719.

E-mail address: sshin@partners.org (S. Shin).

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university-based institute (Program in Infectious Diseases and Social Change, Harvard Medical School, Boston), and the Peruvian National Tuberculosis Program (NTP). Peru established a strong treatment program for pan-susceptible TB in the early 1990s and is noted to be a global leader in the management of the disease. A backlog of drug-resistant cases coupled with ongoing transmission of drug-resistant strains, however, led to a substantial MDR-TB problem in Peru. Given the strong pre-existing DOTS program for the treatment of pan-susceptible TB, the established collaborative decided to focus on the problem of treating MDR-TB. Patient characteristics and treatment response have been described elsewhere, with cure rates of over 80%, comparable to those achieved in US HIV-negative cohorts (Mitnick et al., 2003). While community participation in DOT programs has long been established, this was the first community-based DOT program dedicated to treating MDR-TB (Farmer, Kim, Mitnick, & Timperi, 2000). Cost-based analyses of the program are currently underway, although given the community-based nature of treatment it is expected that the costs per patient treated will be far below those seen in the treatment of patients with MDR-TB in the United States.

Several years later, the term "DOTS-Plus" was coined to refer to MDR-TB treatment programs implemented within the DOTS strategy in low- and middle-income countries (Espinal, Dye, Raviglione, & Kochi, 1999). Here, we describe the first community-based DOTS-Plus program and detail the process of its implementation and expansion.

This program is one example of the ways in which complex health interventions can be implemented in resource-poor settings (Partners in Health, 2002). Ironically, many of the most challenging health problems facing the world today are disproportionately located in the world's poorest communities. Often, these health problems are deemed too difficult, complicated, or expensive to treat in such communities (Espinal et al., 1999), leaving those who suffer with little recourse. It is becoming increasingly clear, however, that problems such as MDR-TB and AIDS can be managed outside of wealthy countries using community-centered models of care. This paper will describe one such program.

Study population and methods

The DOTS-Plus program operates within the existing infrastructure of the NTP to provide treatment to all patients with MDR-TB living in metropolitan Lima. Overall adherence rate to second-line therapy is greater than 90%. The community-based partner in this alliance, Socios En Salud (SES) consists mainly of a team of nurses and health promoters who oversee community DOT volunteers.

Methods

A team of anthropologists has been working with the MDR-TB treatment program since its inception. A qualitative study on the evolution of the program was conducted using multiple methods to allow for triangulation and validation of research findings. Participant observation was carried out by a team of trained ethnographers for a period of 7 years, beginning with the enrollment of the first patient in therapy to the larger scale-up of the project. Participant observation was carried out among the team providing care as well as the patients receiving care and took place in a variety of settings, including the health centers, hospitals, communities, and in patient homes. Detailed field notes were kept during this period and were analyzed for theme and content. This was done by analyzing each encounter and noting the main themes. These themes were then assigned code numbers and each encounter re-analyzed to assess for the presence of these coded themes. A series of informal interviews was carried out with the program manager, program employees, and patients enrolled in the program. The data were then analyzed for theme and content using the method described above. From the data gathered during participant observation and informal interviewing, a series of formal interview guides were developed and then used to conduct in-depth interviews with key participants, including nurses, health promoters, physicians, and patients. In addition to these formal interviews, a documentary review of patient records, employee experiences, institutional growth, and funding progress reports was conducted. All data were analyzed for theme and content as described above by a team of trained ethnographers.

Background and project history

In 1996, the first contract signed between SES, the Peruvian NTP, and Partners in Health provided for treatment of 10 MDR-TB patients in the Northern Cone of Lima. Since its inception, the program has expanded to cover all districts within metropolitan Lima, with plans for national coverage within the next 2 years. The program's development can be divided into three phases (see Table 1). The first phase includes the establishment of the project and initiation of the first cohort of 10 patients (1995–1996); the second phase allowed expansion to cover all MDR-TB patients referred within three northern districts (1997–1998); finally, the program has expanded to provide treatment throughout metropolitan Lima with plans for national coverage (1999–present).

Table 1
Phases of expansion of MDR-TB treatment program in Lima, Peru

	Phase 1: 1996	Phase II: 1997–1998	Phase III: 1999–2002
Patients enrolled	10	57	1046
DOT workers	0	18	268
SES health promoters	11	12	29
SES nurses	0	2	5
NTP physicians	1	5	6
SES physicians	2	4	6
Pharmacy personnel	0	1	4
Administrative personnel	3	6	26

The stages of development of this project are outlined in the following section.

1995–1996 *start-up*

SES was established in 1995 with the mission of creating a preferential option for the poor living in "Tincopa", a squatter settlement in Northern Lima, Peru. Twelve health promoters, young adults who had been working with a local community youth group, were recruited and underwent training in topics ranging from communication and leadership skills to epidemiology and survey design.

With the help of a local parish, a two-story office building was constructed on a plot of land in the urban slum "Tincopa". The building had several computers and three offices, as well as several examination rooms. Like all the buildings in the area, the office was susceptible to shortages of electricity, telephone lines, and water, which typically occurred on a weekly basis.

Through household surveys conducted by SES health promoters, MDR-TB surfaced as a pressing issue in the community. Several of these patients were referred to SES for clinical evaluation where drug-susceptibility testing (DST) revealed the first cases of MDR-TB. SES promoters sought to identify more cases, conducting door-to-door inquiries in the foothills of the community, and flipping through treatment cards in health centers to identify "chronic tuberculous patients". One health promoter recalls,

> When it was discovered from the study that there was [drug-resistant] tuberculosis in the community, we then began to look through the 'historias' [patient charts] at different health centers to see if there were cases of tuberculosis. We were looking for patients who could not be cured, and one by one we found them. We asked about their life, how were they? Were they living or not living and whose patient were they? Blanca Flores[1] was a patient like this with TB and afterwards it was the Rodriguez's—Marta and Julia Rodriguez, and then Lucet; then Brenda Huaman, Jorge Angulo and with them we began to work with TB: not just TB, but multi-drug resistant TB. *Bernabe, a health promoter*

After arriving at a collaborative agreement with the NTP, SES enrolled 10 MDR-TB patients referred by local health centers as "chronic tuberculous patients". All patients were treated within the existing NTP infrastructure with the additional support of SES. This support included DST and second-line medications. The NTP proceeded with the regulatory paperwork to allow the entry and sale of these medicines in the country. Meanwhile, a storage room was allotted in the "Tincopa" office, and a volunteer designed a program that would track medication inventory, purchases and dispensation. A secretary and drug dispensary supervisor were hired, both young adults from the "Tincopa" community. A medical student volunteer from Boston was dedicated to ongoing clinical care of the patients in treatment, in coordination with the local NTP pulmonologist. Experienced infectious disease clinicians from PIH visited "Tincopa" regularly to monitor patient progress. In addition to the SES health promoters, several community members were trained to assist as DOT volunteers.

Antonia's Story—SES's first patient.

SES's first MDR-TB patient, Antonia, came into treatment earlier than expected. She was brought to SES's attention by a health technician at a local health center not far from the SES office. In 1988, Antonia was first diagnosed with TB. She entered treatment through MINSA's standardized Esquema 1 in that same year. By 1994, Antonia remained very sick with TB. She was very conscientious about taking her pills, attending her clinical appointments, and getting all her lab analyses done. Antonia was a woman who cared about her own health and desperately wanted to get better. Her condition, however, would continue to deteriorate.

When Antonia came to the attention of Socios En Salud's director, the decision was made to provide her treatment. The necessary second-line drugs were purchased in Boston and sent to Lima, where Peruvian customs officials levied a tremendous tax on the package and were slow to release the shipment.

[1] All names used in this text are pseudonyms to protect the identity of participants.

Just as she began to receive treatment at SES in January of 1996, her only son died of TB because he refused to be treated by MINSA in the same disgraceful manner that he felt his mother had been treated. His collapse led Antonia to started faltering in her commitment to continue taking here medicines. Antonia lost hope and ultimately became the first "fallecido"—the polite Peruvian way of saying deceased. She had died a mere four days into her new treatment. The medicines had come too late to keep her alive.

When asked whether there were other cases of drug-resistant tuberculosis, the referring health technician didn't know how to respond. "Drug-resistant tuberculosis" was frankly not a term that people used in the nursing TB treatment community. However, when presented a different way—are there patients who didn't get better even though they took their pills?—the answer was, yes! many, many just like Antonia. *Valia, Director of Public Relations, Socios en Salud*

1997–1998 *coverage of Cono Norte*

As SES health workers gained the trust of NTP providers and the first group of patients began to clinically improve, referrals began to inundate the SES office. Nurses from local health centers would wait for hours on the days that SES's patients were seen by the pulmonologist to thrust a chart onto the table for review. Siblings and children of SES patients would approach the health promoters, describing how they, too, were in treatment for TB and were not getting better. Parents would knock on the SES office doors at night, seeking a moment to plead with the SES staff for treatment for their dying child.

Once funds for medications were ensured, SES approached the NTP to discuss how to treat all the patients with MDR-TB, now that it was clear that there were hundreds of cases in need of therapy. SES and the NTP agreed to enroll all MDR-TB patients living in the Northern Cone of Lima in the new treatment program, which by then had become known as "DOTS-Plus". To accommodate these new patients, it was necessary to provide medications and the comprehensive care provided to the first 10 patients. At this point, five nursing students from the community were integrated into the SES team and assumed the leadership of project. Because many of the leaders in the NTP program were nurses, the leadership of the SES nurses was easily accepted by their Ministry of Health (MINSA) counterparts. Within SES, nurses were responsible for overseeing the SES health promoters as well as community-based DOT volunteers. Each nurse would be responsible for 25–30 patients, while SES promoters would oversee approximately 10 patients, and each DOT volunteer would daily supervise the treatment of 3–4 patients. Additional SES promoters and DOT volunteers were trained in order to maintain adequate coverage. Other staff members hired during this phase included two more secretaries, two more individuals assisting the drug dispensary supervisor, and several drivers to provide the critical service of transporting personnel, medications, and food donations around Northern Cone.

Daily morning rounds were conducted to ensure staff communication, and cellular phones with walkie-talkie systems were distributed to health workers and nurses to allow constant communication in the field. Internet communication became increasingly essential, as complicated patient management issues were conveyed by nurses to volunteer physicians in Boston, who would then discuss these cases with the local NTP pulmonologist. At this time, computer programmers in Boston began to work on an Internet-based patient record with the aim of providing a clinical tool for patient care as well as a data repository for clinical and epidemiological research.

1999-Present. Lima-wide expansion and beyond

Parallel to the expansion occurring on the local level, ongoing efforts to reduce the cost of second-line drugs and increase the international political and financial support for DOTS-Plus were gaining ground (Farmer, 2001). Once funds were available, SES made the next move of expansion: treatment would be made available to all patients with MDR-TB in metropolitan Lima and ultimately throughout the country. To date, more than 1000 patients have received MDR-TB therapy. While these patients are primarily residents of metropolitan Lima, approximately 50 patients have been referred from provincial districts and have resided in Lima for the duration of treatment, receiving housing, and nutritional support from SES.

Six additional Peruvian pulmonologists were trained through an international fellowship in the treatment of MDR-TB. Each pulmonologist is responsible for the care of all patients receiving individualized MDR-TB therapy within his or her district. Twelve additional pulmonologists are in the process of participating in this fellowship at the time of this writing. Furthermore, training is currently ongoing in the provinces, in order to provide national coverage within the next several years.

SES has also expanded. Three more nurses have been hired, as well as approximately a dozen health promoters and hundreds of DOT volunteers. At least two physicians from Boston are dedicated to patient care full-time and work closely with the team of Peruvian pulmonologists to coordinate treatment initiation, follow-up, and emergency evaluations.

This phase of the project has required the most rapid and extensive growth. The office building in "Tincopa" did not provide sufficient space; therefore, a second office space was obtained in central Lima which houses multiple offices, conference rooms (including videoconference capacity), and storage for patient records and radiographs. The original building has also been expanded, in particular to provide a larger and better-ventilated space for the drug dispensary.

In addition to the clinical team, ancillary staff has grown. Four additional workers have been trained to supplement the dispensary team. Providing a secretary for each nurse, as well as a secretary for the clinicians, has reduced the amount of time spent on documentation and has significantly increased the organization and efficiency of the team. All nurses and secretaries are now proficient in the use of the Internet and each nurse/secretary team has a computer. A data management team and information technology (IT) team has been established. Several receptionists, as well as a team of approximately 12 drivers, allow for efficient communication, and movement throughout the city.

Communication through daily rounds has become increasingly difficult given the quantity of patients in treatment. Currently, the majority of patient data is maintained in paper charts belonging to the NTP and an Internet-based electronic medical record designed by Partners in Health. The data includes culture and smear data, DST, initial treatment data, laboratory tests, radiographic results, and TB medications. This data are available through Internet access by physicians in all collaborating sites: Boston, Peru, Haiti, and Russia. This program also serves as the database for the drug dispensary, so that purchasing, supplies, and dispensation of medications are linked to physicians' orders and an up-to-date treatment regimen list. The future goal is to integrate this database into the NTP system, where all data will be entered allowing direct access by NTP physicians to the patient's medical record.

Discussion

Key components of the DOTS-Plus program

The extension of DOTS-Plus coverage from 10 patients in a neighborhood in Northern Lima to over 1000 patients throughout the Lima metropolitan region has brought numerous logistical challenges. We have identified several crucial aspects that were essential at each phase of the program's development. These included: the formation of an integrated team, intensive training, emphasis on community-based ambulatory patient care and remediation of socioeconomic factors that contribute to adverse treatment outcome.

Integrated team

The DOTS-Plus program in Lima is similar to the DOTS model; the team is made up of physicians, nurses, health promoters, DOT volunteers, pharmacy personnel, laboratory personnel, and administrative personnel (Maher et al., 1997). Community members have been successfully trained to fill a majority of the roles, even though most of these individuals lack prior training in the management of TB. Interactive participation across professional and geographic boundaries has been critical to program success. Daily rounds, whether in person or through email discussions, and detailed chart reviews have at various points ensured that all staff are kept abreast of the details of individualized patient management.

Community health workers

Community health worker (CHW) programs have been widely employed throughout the world, and have been successfully used to treat a broad spectrum of health problems ranging from diarrheal disease and TB to malaria and asthma (Ramprasad, 1988; Ronsmans, Bennish, & Wierzba, 1988; Christensen & Karlqvist, 1990; Ghebreyesus et al., 2000; Mburu, 1994; Rifkin, 1996; Walt, Perera, & Heggenhougen, 1989; McCord & Kielmann, 1978; Quigley & Ebrahim, 1994; Butz et al., 1994; Zeitz, Harrison, Lopez, & Cornale, 1993). Two levels of CHW responsibilities exist in our program. First, specialized CHWs (SES health promoters) are trained in community outreach and basic medical issues related to MDR-TB. They oversee a second, larger group of CHWs, the DOT volunteers. Both types of workers frequently visit patient homes and have close rapports with the patients and their families.

DOT volunteers supervise doses that cannot be administered at health centers. While some DOT volunteers are recruited from NTP health centers, most are identified through community-based health organizations, such as "Plato de arroz" (a nutritional support group), local comedores (soup kitchens), and church groups.

DOT volunteers supervise up to four patients who live near their homes. While DOT volunteers are responsible primarily for the supervision of DOT, their role is more comprehensive. As the primary contact with the patient and the patient's family, DOT volunteers are often the first to identify and report symptomatic family contacts, adverse medication side effects, TB-related complications, and psychosocial stressors that threaten to affect a patient's adherence. DOT volunteers are also the mainstay of psychosocial counseling for the patient during therapy. As summarized by one of the SES nurses:

> The DOT community health workers are the most important part [of the team], because they inform us immediately if there has been a problem, …that the dose was lost, or that the patient did not want to take the medicine, or that this patient would like to abandon the program… They are there to listen to what the patient says, about their family problems, their economic problems, problems in their studies or in their work. *Alicia, a nurse*

Nurses

As the central coordinators of patient care, nurses are critical to care of patients with MDR-TB (Palacios, Guerra, Llaro, Chalco, & Furin, 2003). They ensure that physicians' orders are carried out, triage cases to be evaluated by both NTP and SES physicians, supervise CHWs, and oversee data collection and maintenance of patient records.

> We [nurses] have a lot of liberty to make the plans in our zones and to see to the needs in our zones, in our patients. Although we have plenty of freedom, [when there are] any doubts or problems with the coordinators, the Ministry, or the patients, we [nurses] consult among ourselves… Everything is done for the best of the patient… We are responsible for everything that happens with the patient. *Alicia, a nurse*

Importantly, coordination of complex patient care is possible only through constant communication between SES and NTP nurses. In addition, patients with active clinical issues, such as TB-related symptoms and adverse effects are often successfully managed as outpatients thanks to assiduous nursing care and close communication between nurses and physicians. The nurses act as case managers for each patient enrolled in DOTS-Plus, and they have primary responsibility for ensuring DOT, following smear and culture results, monitoring for adverse side effects, and evaluating nutritional and social support.

Physicians

In SES, the nursing team is complemented by the team of physicians, who are experts in the clinical management of MDR-TB. The SES physicians serve to facilitate and complement the work of the NTP pulmonologists in patient care; initial evaluations and complex cases are seen together by physicians from both organizations. Routine follow-up is performed by the NTP pulmonologists. General practitioners at NTP health centers also see patients for minor side effects; in addition, Ministry of Health specialists, including psychiatrists, neurologists, endocrinologists, HIV specialists, nephrologists, obstetricians, pediatricians, and thoracic surgeons are all crucial participants in the care of more complicated patients.

Ancillary staff

The project has several key administrative and support staff in place, all of whom are essential in running the day-to-day activities. These personnel include administrative staff, pharmacy personnel, 24-h phone operator, social workers, accountants, data entry personnel, and technical advisors.

Training

Training is an essential part of TB and MDR-TB control programs (Fanning, 2000; Ditiu, 1999; Edginton, 1999; Enarson, 1991). The creation of a DOTS-Plus team has required intensive initial training, but it has produced a highly trained and motivated group of health workers. The sophistication and ingenuity of their skills are evidenced by the successful expansion of the program to cover all of metropolitan Lima.

Both initial and continuous training are an integral part of the DOTS-Plus program. Careful preparation and preemptive training has allowed the project to have key personnel ready in advance of program expansion. We have found that using standardized algorithms aids in the management of complex health interventions such as MDR-TB. A series of algorithms were therefore developed to guide the management of major treatment decisions, adverse reactions, and TB-related complications. These algorithms have been incorporated into a comprehensive MDR-TB treatment manual, as well as the training curriculum presently in use both in Peru and in other countries (Partners in Health, 2002). Examples of complicated clinical issues that can be guided by a standardized protocol include management of patients with persistent smear-positivity, evaluation and treatment of respiratory insufficiency, and approach to psychosis. These protocols provide a flexible template for all healthcare providers to follow as a team.

All new SES health promoters and DOT volunteers now receive a 1-day training course to learn about medications used in DOTS-Plus therapy, common and life-threatening side effects, and TB complications. Additionally, they shadow experienced promoters and volunteers "in the field" prior to working independently. It is during such exposure that new workers are able to observe interactions with patients and health workers and to learn, most importantly, how to treat patients with dignity and how to work in solidarity with them.

On this latter point, it is clear that workers (both in SES and the NTP) can be trained in the larger mission of creating a preferential option for the poor. It is our experience that by maintaining a standard of respectful behavior toward patients as an institution (SES), the behavior and attitudes of those who work for and with

us can be shaped. Patients of SES consistently note that they are treated with respect and without gestures of marginalization, disgust or pity. Behavioral changes among physicians and health workers have been observed not only among those working at SES, but among those working in the NTP as well.

New nurses working for SES undergo a training course consisting of 2 days of didactic lectures, workshops, and a review test. Nurses are trained in principals of MDR-TB therapy, side effect and TB-complication management, TB epidemiology, as well as computing skills. Although none of the SES nurses had computer skills when they began working, they have become proficient in the management of basic programming and the use of the Internet in a short period of time. In addition to their patient care responsibilities, the nurses have also played an important role in training others. They have created their own training materials, most of which did not exist at the beginning of the program.

NTP personnel (including nurses, laboratory personnel, health technicians, and physicians) receive training prior to the implementation of DOTS-Plus in their center. Once a patient is enrolled in their health center, SES nurses and health promoters visit the health center frequently (often daily at first) to review medications, administration, documentation, and follow-up protocols (for routine clinical, radiographic, laboratory, and bacteriologic evaluations). Any adverse effect experienced by the patient serves as practical training, wherein experienced SES and NTP health workers orient the health center team to existing clinical algorithms for side effect management.

NTP physician training consists of formal didactic teaching sessions as well as one-on-one clinical training with a visiting specialist, seeing patients together on a weekly basis. Periodic workshops, seminars, videoconferences, and lectures comprise ongoing training for reinforcement as well as review of the most recent international developments in MDR-TB epidemiology, molecular biology, and clinical management.

Community-based patient care

An integrated well-trained team creates the foundation for carrying out an effective community-based DOTS-Plus program. The key components of community-based strategy include active outreach, comprehensive ambulatory patient care, close coordination of with the NTP, and close communication with patients and families.

Active outreach

Since the beginning of this program, aggressive outreach has been fundamental to identifying MDR-TB patients in a timely manner. While the majority of patients are referred by NTP health centers, many of these patients must be located and recruited for enrollment into treatment. It is not uncommon for patients who have failed multiple regimens to lose interest in pursuing further treatment. Therefore, health workers (including physicians, nurses, and CHWs) often conduct home visits to actively seek out MDR-TB patients. Open discussion can often identify factors which contributed to non-adherence or default, including loss of confidence in TB therapy, financial stressors, lack of psychosocial support, and disabling advanced disease. Most patients are willing to undergo DOTS-Plus therapy faithfully if they know that they have a reasonable chance of cure.

In addition, outreach also enables diagnosis of other MDR-TB cases that would not readily be identified in a timely fashion. Because most of the nurses, health promoters and DOT volunteers live in the same community in which they work, they often have access to information about symptomatic cases who may not readily seek attention at health centers. In addition, they provide constant surveillance for symptomatic cases within the household of DOTS-Plus patients. Many household contacts have been precociously diagnosed with MDR-TB and triaged into DOTS-Plus therapy through this manner.

Finally, among patients undergoing DOTS-Plus therapy who experience difficulties with adherence, early intervention by the healthcare team with frequent home visits may prevent default and improve adherence. Intensive patient and family discussions, as well as analysis and remediation of contributing stressors are part of the active outreach role played by the physicians, nurses, and health promoters of the SES team.

Comprehensive ambulatory patient care

NTP staff and DOT volunteers are responsible for delivering DOT of all doses that the patient receives. Constant vigilance and reinforcement is necessary to prevent circumstances where patients are allowed to take their medications on their own. Surprise visits to health centers and patients' home are conducted to assess DOT. The approach for DOT must be firm, yet supple. Health workers must insist with unfaltering patience in administering the patient's medications under direct observation; however, accommodations should be made whenever possible to allow for work and family obligations of the patient. DOT may be given at a patient's workplace or, for privacy, in a restaurant nearby.

In addition to providing DOT, the work of the DOT volunteer is both dynamic and demanding. As the frontline of patient contact, the DOT volunteer must respond to many clinical developments, including adverse reactions, and TB-related complications. They may be confronted with emergency situations, such as hemoptysis or psychosis. Clinical protocols are available

to guide management in most of these scenarios. A system of 24-h backup is in place; SES health promoters, nurses, and physicians are available to attend to any emergencies if the DOT volunteer finds the patient to be clinically unstable.

The responsibilities of the SES team often extend beyond managing TB-related issues. Patients with other chronic disease, such as depression, diabetes mellitus, and HIV, often benefit from direct supervision of non-TB medications. In addition, psychosocial issues such as substance abuse and domestic violence frequently surface given daily contact within patients' homes. SES workers and DOT volunteers are trained and capable of providing emotional support, counseling and facilitating referrals for help in these areas.

Not only is SES concerned with the psychological and physical well-being of their patients, but SES often attends to the needs of the patient's family. When a patient's child becomes ill, the illness adds yet another strain on their lives. Magdalena, one of the SES nurses observes,

> One of the big family problems is with the kids. If a patient has four little children and the husband has problems with her…and doesn't care much about these problems, it can be very depressing and nothing matters… "I have to skip the doses in the night because I can not leave my children alone". *Magdalena, a nurse*

SES views these familial illnesses as additional risk factors for failing MDR therapy and increasing disease transmission to family and friends. To address these risks, family support is included in the patient's case management. For example, SES physicians are often willing to see other members of the patient's family, and medications are donated, when available, from the SES inventory if the family is unable to afford them. Heath promoters work with the family to ensure that sick members are seen at local health centers.

Coordination with national tuberculosis program

SES cooperation with NTP has been important in the successful delivery of patient care; maintaining good interagency communication remains one of the most critical challenges to the DOTS-Plus program. SES staff routinely accompany the patient to any clinical consultation and ensures that the results of any laboratory, bacteriologic, or radiographic tests performed by SES are available. Both NTP and SES strive to maintain complete records on patient progress, but it is a daily challenge to ensure that important patient information is exchanged to maintain consistent documentation in two different data systems. Duplicate charts are kept at SES and the NTP; all physician notes are written with a carbon copy. SES relies upon NTP health centers for sputum and culture results, while the NTP receives DST data on second-line drugs through SES. All such results are photocopied and placed in both charts.

Aside from documentation, patient care must also be closely coordinated between SES and the NTP. Through assiduous work and diplomacy, cooperation between SES and NTP has advanced significantly and has likely contributed to improvements in the treatment of TB patients in Lima as a whole. For example, SES health promoters assist in the DOT of both MDR-TB and susceptible TB patients in NTP health centers during busy and/or understaffed hours. As NTP health workers gain greater familiarity with MDR-TB patients and witness cures in cases that had previously been considered incurable, morale and interest improve on the part of these personnel. A SES nurse states,

> It makes me happy when the staff of the Ministry of Health becomes more dedicated to these patients. It gives me a great deal of happiness to see the staff of the Ministry begin to become interested in their patients. They call me and then you see that it isn't only you that is making the calls… Sometimes a nurse or technician will call and I can hardly believe it. "Senorita", they say, "I have always been bothered by this one. Look at this little patient". And then we go and make a home visit. *Magdalena, a nurse*

Though interagency cooperation has brought with it many challenges and complications, by and large interactions have been to the benefit of SES, the Ministry of Health, and the TB patients.

Addressing larger factors

Many of the factors that determine TB treatment outcome are not biological but rather socioeconomic and psychosocial. As poignantly stated by Kironde and Nasolo (2002), "Effective community-based TB control requires comprehensive initiatives that need to incorporate efforts to address the root causes of disease, notably poverty and its resultant ills".

Poverty remains an overwhelming risk factor for TB-related mortality. Malnutrition, inability to work, and social isolation all stem from the synergistic forces of TB and poverty. While poor to begin with, many patients are too sick to work and are burdened by the costs of medical attention. This cycle of disease is often compounded by additional family members with TB. Haydee, a SES nurse, describes her initial assessment of these risk factors:

> When one goes to a house, from the moment that you see the house, you can see under what conditions the person is living. There are simple things like whether there the roof is made of tin or whether the

> home is made of clay bricks with plastic sheets on top to cover the house from the rain. You also might notice that it is one small room where so many people live and in those small moments one can tell the story of the conditions of life of the patients. *Haydee, a nurse*

The community-based programs of Partners in Health in other areas have strived to impact some of these factors (Farmer, Robin, Ramilus, & Kim, 1991; Marshall, Behforouz, Reddy, & Kim, 2001). Likewise, this DOTS-Plus project has incorporated measures to address larger socioeconomic and psychological stressors that shape the lives of patients with MDR-TB. The SES team includes an economics student and social worker who evaluate the socioeconomic status of all patients who are referred for possible financial, nutritional, and/or housing assistance.

Socioeconomic interventions undertaken by SES vary widely depending on the economic situation of the patient, but at the most basic level of assistance, SES strives to prevent any increased economic burden from being incurred by the patient as a result of undergoing treatment: a patient that emerges from therapy penniless and destitute is at high risk of relapse. Thus, all primary and secondary medications prescribed by SES are offered to the patient free of charge. For costs of specialist consultations, surgical costs, laboratory and imaging fees, SES encourages patients to apply for hospital discounts, which, based on the assessment of hospital social workers, can range from 30% to 50%. SES may cover some or all of the remaining cost depending on patient need. When necessary, transportation stipends are offered to cover the cost of going to and from clinical visits.

Food security in general is an essential consideration in the treatment of MDR-TB patients. Not only is treatment less likely to succeed if patients are malnourished, medication side effects become much more pronounced and difficult to manage. Sometimes SES pays local soup kitchens to provide a meal or two a day for the patient. In other cases, local community organizations donate monthly food packs to patients.

Although a majority of the MDR-TB patients have stable housing, SES will often help homeless patients find a room to rent and, when necessary, subsidize housing costs. Housing has been established in each district for patients who come from the provinces for treatment and have no relatives in Lima.

Food and housing assistance are a great help to patients during treatment, but in the long-term most patients will state that what they need most is employment. As patients near the end of their treatment, they and social workers alike turn greater attention to transitioning off economic assistance. By supporting the patient's recovery without plunging them into debt, simple medical intervention goes a long way to returning patients to the workforce; nevertheless, post-treatment unemployment remains a major problem. The problem of reintegration into the workforce is complex, since patients are often unskilled, and work opportunities are severely limited in the current Peruvian economy. In some instances SES has been able to provide people sustainable incomes by giving them capital toward private employment. For example, one patient, Elena Sanchez, was given money to set up a newsstand. Another patient was given the capital to purchase candy that she could sell as a street vendor. Sometimes the most viable option is to find work for the patient's spouse or children to create an income that can support the family as a whole. Nevertheless, transitioning patients to economic self-sufficiency remains one of the program's most difficult challenges.

In addition to the effects of poverty, those of extreme social isolation cannot be underestimated. Depression from a chronic disease is often compounded with the societal rejection that patients often experience. It is not uncommon for patients to be rejected or isolated to some degree by their own family. Many patients carry around with them years of distrust and resentment toward all medical establishments. Over the course of 2 years, contact with DOT volunteers, health promoters, nurses, and physicians who treat all patients with dignity and respect can have tremendous impact on patients' sense of well-being.

Moral support and counseling is not only provided through daily contact with patients and their families. In addition, psychiatrists and group therapy sessions among patients provide additional arenas of psychosocial support (Sweetland, Acha, & Guerra, 2002). Group therapy sessions are now being established within each district; patients who have already completed treatment continue to participate in group therapy in order to provide testimony to others who are struggling to recover.

Conclusion

Community-based models for the treatment of TB, including DOTS, have been extremely effective and widely accepted. A similar model of care, DOTS-Plus, has been applied to the treatment of multidrug-resistant strains of TB with success in Lima, Peru. Scale-up of this program from the treatment of a small cohort of 10 patients in one small peri-urban community to the treatment of over 1000 patients, primarily in the Lima area but also from outlying provinces, has required substantial new infrastructure development. The experiences of SES in the creation and development of local to national treatment delivery infrastructure offer many explicit lessons for the treatment of complex health

problems in resource-poor settings. Chief among these future directions include the development of MDR-TB control strategies for neighboring nations and other TB hot-spots. In the words of SES's director, ''Unless we turn off all sources of this epidemic, our work will only be half complete''. With increasing transnational migration, ambitious plans for transnational disease control must be developed, piloted, and tested. The SES expansion, including the parallel development of its distant Russian counterpart, offers a model of local to national to international expansion of MDR-TB control that remains community-based in function and spirit. Expansion of this program to Peru's neighbors requires only time and the political negotiation to proceed.

MDR-TB treatment is unfortunately long and complex. In poor settings, treatment of MDR-TB will likely continue to require a community-based approach that involves a team of dedicated care providers and a multidimensional intervention including psychosocial, economic, and medical support. Such an approach to community-based care provides a useful blueprint for the management of other chronic medical conditions. As the burden of chronic illnesses like substance abuse and mental illness begins to shift to regions of deepening poverty, good examples of community-based medical care will be urgently needed. Already, SES's DOT workers have begun to supervise medications used to treat other illnesses, including diabetes mellitus, mental health disorders, and HIV. An emphasis on psychiatric well-being, including group psychotherapy and individual counseling, is built into the SES approach.

This paper outlines how one complex health problem—MDR-TB—was successfully addressed in Peru and the necessary organizational components that were required for such management. The key elements in this program may be useful in addressing other health problems plaguing poor communities and are an example of a ''complex health intervention in poor settings'', or ''CHIPS'' (Partners in Health, 2002). A future challenge remains: to adapt this highly specialized team to addressing another disease, that of HIV. While the existing team is rigorously trained in the treatment of MDR-TB, we feel that it is sufficiently flexible and sophisticated to confront the coexisting threat of HIV in poor communities in Peru. Indeed, the components of the DOTS-Plus program—an integrated team, intensive training, community-based patient care, and addressing socioeconomic factors contributing to health disparity—provide the foundations necessary to adapt a community approach to any disease or complex of diseases.

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References

Butz, A. M., Malveaux, F. J., Eggleston, P., Thompson, L., Schneider, S., Weeks, K., Huss, K., Murigande, C., & Rand, C. S. (1994). Use of community health workers with inner-city children who have asthma. *Clinical Pediatrics*, *33*, 135–141.

Chaulk, C. P., Moore-Rice, K., Rizzo, R., & Chaisson, R. E. (1995). Eleven years of community-based directly observed therapy for tuberculosis. *JAMA: The Journal of the American Medical Association*, *274*(12), 945–951.

Christensen, P. B., & Karlqvist, S. (1990). Community health workers in a Peruvian slum area: An evaluation of their impact on health behavior. *Bulletin of the Pan American Health Organization*, *24*, 183–196.

Ditiu, L. (1999). National tuberculosis programme in Romania 1997–2000: How it works. *Central European Journal of Public Health*, *7*, 189–190.

Edginton, M. E. (1999). Tuberculosis patient care decentralised to district clinics with community-based directly observed treatment in a rural district of South Africa. *International Journal of Tuberculosis and Lung Disease*, *3*, 445–450.

Enarson, D. A. (1991). Principles of IUATLD collaborative tuberculosis programmes. *Bulletin of the Pan American Health Organization*, *66*, 195–200.

Espinal, M. A., Dye, C., Raviglione, M. C., & Kochi, A. (1999). Rational 'DOTS plus' for the control of MDR-TB. *International Journal of Tuberculosis and Lung Disease*, *3*, 561–563.

Fanning, A. (2000). The importance of education, training and supervision in global TB control. *International Journal of Tuberculosis and Lung Disease*, *4*, S208–5214.

Farmer, P. (2001). DOTS and DOTS-Plus: Not the only answer. *Annals of the New York Academy of Sciences*, *953*, 165–184.

Farmer, P., Robin, S., Ramilus, S. L., & Kim, J. Y. (1991). Tuberculosis, poverty and ''compliance'': Lessons from rural Haiti. *Seminars in Respiratory Infections*, *6*(4), 254–260.

Farmer, P. E., Furin, J. J., & Shin, S. S. (2000). Managing multidrug-resistant tuberculosis. *Journal of Respiratory Diseases*, *21*(1), 53–56.

Farmer, P. E., Kim, J. Y., Mitnick, C. D., & Timperi, R. (2000). Responding to outbreaks of MDRTB: Introducing DOTS-Plus. In L. B. Reichman, & E. S. Hershfield (Eds.), *Tuberculosis: A Comprehensive International Approach* (2nd ed.) (pp. 447–469). New York: Marcel Dekker.

Floyd, K., Wilkinson, D., & Gilks, C. (1997). Comparison of cost effectiveness of directly observed treatment (DOT) and conventionally delivered treatment for tuberculosis: Experience from rural South Africa. *British Medical Journal*, *315*, 1407–1411.

Fox, W. (1983). Compliance of patients and physicians: Experience and lessons from tuberculosis—I. *British Medical Journal*, *287*, 33–35.

Ghebreyesus, T. A., Witten, K. H., Getachew, A., Yohannes, A. M., Tesfay, W., Minass, M., Bosman, A., & Teklehaimanot A, . (2000). The community-based malaria control programme in Tigray, northern Ethiopia. A review of programme set-up, activities, outcomes and impact. *Parassitologia*, *42*, 255–290.

Hurtig, A. K., Pande, S. B., Baral, S. C., Newell, J., Porter, J. D., & Bam, D. S. (2002). Linking private and public sectors in tuberculosis treatment in Kathmandu Valley, Nepal. *Health Policy and Planning*, *17*, 78–89.

Iseman, M. D., & Goble, M. (1996). Multidrug-resistant tuberculosis. *New England Journal of Medicine*, *334*(4), 267.

Iseman, M. D., Madsen, L. A., Goble, M., & Pomerantz, M. (1990). Surgical intervention in the treatment of pulmonary disease caused by drug-resistant *Mycobacterium tuberculosis*. *The American Review Respiratory Diseases*, *141*(3), 623–625.

Kironde, S., & Klaasen, S. (2002). What motivates lay volunteers in high burden but resource-limited tuberculosis control programmes? Perceptions from the Northern Cape province, South Africa. *International Journal of Tuberculosis and Lung Disease*, *6*(2), 104–110.

Kironde, S., & Nasolo, J. (2002). Combating tuberculosis: Barriers to widespread non-governmental organization involvement in community-based tuberculosis treatment in South Africa. *International Journal of Tuberculosis and Lung Disease*, *6*(8), 679–685.

Maher, D., Gorkom, J. L. C., Gondrie, P. C. F. M., & Raviglione, M. (1999). Community contribution to tuberculosis care in countries with high tuberculosis prevalence: Past, present and future. *International Journal of Tuberculosis and Lung Disease*, *3*, 762–768.

Maher, D., Hausler, H. P., Raviglione, M. C., Kaleeba, N., Aisu, T., Fourie, B., & Nunn, P. (1997). Tuberculosis care in community care organizations in sub-Saharan Africa: Practice and potential. *International Journal of Tuberculosis and Lung Disease*, *1*, 276–283.

Mangura, B., Napolitano, E., Passannante, M., Sarrel, M., McRonald, R., Galanowsky, K., & Reichman, L. (2002). Directly observed therapy (DOT) is not the entire answer: An operational cohort analysis. *International Journal of Tuberculosis and Lung Disease*, *6*(8), 654–661.

Marshall, R., Behforouz, H.L., Reddy, A., & Kim, J.Y. (2001). HIV Prevention and Access to Care and Treatment (PACT): A case-based approach to community health in Boston. In Jon Rohde & John Wyon (Eds.), *From Bangladesh to Boston: Lessons in Community-Based Care*. Boston: Management Sciences for Health–Harvard Anthology.

Mburu, F. M. (1994). Whither community health workers in the age of structural adjustment? *Social Science & Medicine*, *39*, 883–885.

McCord, C., & Kielmann, A. A. (1978). A successful programme for medical auxiliaries treating childhood diarrhoea and pneumonia. *Tropical Doctor*, *8*, 220–225.

Mitnick, C. D., Bayona, J., Palacios, E., Shin, S., Furin, J., Alcántara, F., Sánchez, E., Sarria, M., Becerra, M., Smith-Fawzi, M. C., Kapiga, S., Neuberg, D., Maguire, J., Kim, J. Y., & Farmer, P. (2003). Community-based therapy for multidrug-resistant tuberculosis in Lima, Peru. *New England Journal of Medicine*, *348*, 1219–1228.

Pablos-Mendez, A., Raviglione, M. C., Laszlo, A., Binkin, N., Rieder, H. L., Bustreo, F., Cohn, D. L., Lambregts-van Weezenbeek, C. S., Kim, S. J., Chaulet, P., & Nunn, P. (1998). Global surveillance for antituberculosis-drug resistance, 1994–1997. World Health Organization–International Union against Tuberculosis and Lung Disease Working Group on anti-tuberculosis drug resistance surveillance. *New England Journal of Medicine*, *338*(23), 1641–1649.

Palacios, E., Guerra, D., Llaro, K., Chalco, K., & Furin, J. (2003). The role of the nurse in the community-based treatment of multidrug-resistant tuberculosis. *International Journal of Tuberculosis and Lung Disease*, *7*, 1–4.

Partners in Health, Harvard Medical School, Bill and Melinda Gates Foundation. (2002). *A DOTS-Plus handbook: Guide to the community-based treatment of MDR-TB*. Boston: Partners in Health.

Quigley, P., & Ebrahim, G. J. (1994). Women and community health workers promoting community health and development. *Journal of Tropical Pediatrics*, *40*, 66–71.

Ramprasad, V. (1988). Community health workers—an evolving force. *World Health Forum*, *9*, 229–234.

Rifkin, S. B. (1996). Paradigms lost: Toward a new understanding of community participation in health programmes. *Acta Tropica*, *61*, 79–92.

Ronsmans, C., Bennish, M. L., & Wierzba, T. (1988). Diagnosis and management of dysentery by community health workers. *Lancet*, *2*, 552–555.

Sweetland, A., Acha, J., & Guerra, D. (2002). Enhancing adherence: The role of group psychotherapy in the treatment of multidrug-resistant tuberculosis in urban Peru. In A. Cohen, A. Kleinman, & B. E. Saraceno (Eds.), *The world mental health casebook: Social and mental health programs in low-income countries* (pp. 51–79). New York: Kluwer Academic.

Tahaoğlu, K., Törün, T., Sevim, T., Atac, G., Kir, A., Karasulu, L., Ozmen, I., & Kapakli, N. (2001). The treatment of multidrug-resistant tuberculosis in Turkey. *New England Journal of Medicine*, *45*(3), 170–174.

Walt, G., Perera, M., & Heggenhougen, K. (1989). Are large-scale volunteer community health programmes feasible? The case of Sri Lanka. *Social Science & Medicine*, *29*, 599–608.

Weis, S. E., Slocum, P. C., Blais, F. X., King, B., Nunn, M., Matney, G. B., Gomez, E., & Foresman, B. H. (1993). The effect of directly observed therapy on the rates of drug resistance and relapse of tuberculosis. *New England Journal of Medicine*, *118*, 139–145.

World Health Organization. (2000). *Anti-tuberculosis drug resistance in the world*. Report No. 2. Geneva: World Health Organization.

Zeitz, P. S., Harrison, L. H., Lopez, M., & Cornale, G. (1993). Community health worker competency in managing acute respiratory infections of childhood in Bolivia. *Bulletin of the Pan American Health Organization*, *27*, 109–119.