eCompliance: Enhancing Tuberculosis Treatment with Biometric and Mobile Technology

Shelly Batra, Sandeep Ahuja, Abhishek Sinha, Nicholas Gordon
Operation ASHA, G-26, first floor, Kalkaji, New Delhi, 110019, India
Tel: +91 11 931 039 8004, Email: shelly.batra@opasha.org

Abstract: Operation ASHA (OpASHA) has used eCompliance as a novel combination of biometric and mobile technology to prevent drug resistant tuberculosis.

eCompliance identifies patients through a finger print reader to verify that they are physically present for treatment. Through SMS, the system automatically synchronizes attendance data into a central medical record giving management up-to-date information on patient attendance. A separate text message notifies health workers of any missed doses that day, requiring them to follow-up within 48 hours.

During a one- year period, over 1,400 patients registered at 26 different eCompliance terminals installed in South Delhi, India. Using interviews and surveys, OpASHAs internal evaluation shows that both patients and health workers perceive that terminals have a positive impact on TB treatment. Analyses of the system's performance show that drug default (defined as two consecutive months of missed doses) reduced to less than 1%.

1. The Problem

1.1 – Tuberculosis in India

Tuberculosis (TB) is an airborne bacterial disease that primarily infects the lungs. It spreads easily through sneezing, coughing and spitting. This is particularly devastating in dense urban zones. For this reason, the epidemic has spread quickly throughout India, which carries the highest TB burden in the world with over 2 million infected [1]. Although the disease is curable, the 6-7 month treatment time has made relapse and drug resistance an enormous public health challenge.

1.2 – MDR-TB Multidrug Resistant Tuberculosis

A Tuberculosis bacterium that becomes resistant to first-line anti-tuberculosis drugs is medically known as multidrug resistant tuberculosis (MDR-TB). The resistance most commonly develops when TB patients stop taking their medication partway through their treatment. Furthermore, this strain is directly transmitted to a new victim. MDR- TB can take over two years to treat with drugs that are more toxic and 50-200 times more expensive, an unaffordable amount for India's poor [2].

In 2008, the World Health Organization (WHO) estimated that 440,000 new cases of MDR-TB emerged globally with nearly half of these cases occurring in China and India [3]. Since the disease is highly contagious and spreads annually to an average of 12 others per infected person, TB spreads exponentially when not treated [4]. Between 2010 and 2015, it is

expected that 1.3 million MDR-TB cases will need to be treated in 27 high burden countries at an estimated cost of US$ 16.2 billion [5].

1.3 – DOTS (Directly Observed Therapy)

To prevent the development of MDR-TB, the WHO adopted the Directly Observed Therapy (DOTS) in the early 1990's. The main component of this treatment requires patients to take TB medicines under the supervision of a healthcare worker. DOTS revolutionized TB treatment, remarkably doubling the cure rate among patients. While the results of the program were a vast improvement in comparison to self-administered treatment, patient default has not decreased enough to stop the growth of this man-made MDR epidemic.

Despite the enormous success of DOTS, the strategy currently suffers from three limitations: verification, slow response time and the lack of digitized records. The first criticism of DOTS is that the program is not always implemented properly because the program cannot verify when a patient has taken his or her medicines, and relies solely on the honesty of the health worker's input. Similarly, it is difficult for DOTS to systematically respond to defaulting patients in a timely manner. Again, this process revolves around the health worker's initiative to provide individual consultation. This is a symptom of the final weakness, which is the absence of digital records in many DOTS programs.

"DOTS alone is not sufficient to curb the TB epidemic in countries with high rates of MDR-TB and large proportions of re-treatment cases" [6]. The lack of verification has limited the effectiveness of DOTS, particularly in areas with low health education. In other words, there is no entity which supervises the supervisors. This has presented a problem when TB institutions offer health workers performance-based incentives, as many employees are inclined to falsify attendance records to reflect improved performance.

Early intervention is an effective method of preventing patient default. When a patient misses his or her first scheduled dose, immediate remedial counseling establishes dedicated compliance. However, the majority of DOTS programs are slow to respond to patients who repeatedly miss their doses when using manual reports. Especially in DOTS centers with high traffic levels, it is difficult to follow-up with patients in a timely manner.

This lag time between the initial missed dose and the remedial counseling is, again, largely because records are not digitized. This prevents information from being viewable by multiple levels of operational management and often the health worker is the only individual with access to such records. "Electronic datasets are also needed to facilitate analysis of data," says the WHO, "for example, to check for internal and external consistency" [7].

2. The Solution: Operation ASHA's eCompliance

2.1 – How eCompliance Works

In 2010, OpASHA launched a biometric initiative called *eCompliance* (previously named eDOTS) at 17 treatment centers in South Delhi, India. The program's objective was to fill these common gaps in the DOTS strategy through an innovation that would be globally accessible, particularly in dense urban and low-literacy areas. In collaboration with Microsoft Research and Innovators in Health, OpASHA developed a terminal using fingerprint reader technology to record every dose taken.

Under the eCompliance initiative, each treatment center is equipped with an eCompliance terminal, consisting of a fingerprint reader and a low-cost SMS modem. When a TB patient visits the treatment center, they verify their visit by scanning their finger on the reader before taking their medicines. The terminal keeps a real-time attendance log. This gives health workers the option of quickly viewing which patients have visited the center, which patients still need to take their medicines and which patients miss their doses the previous day. With use of the fingerprint reader, the system provides unmistakable evidence that a patient was physically present for the treatment.

If a patient misses a dose, the eCompliance terminal automatically sends a text message to the patient's health worker and program manager, notifying them that a follow-up visit is required within 48 hours. During this follow-up visit, the health worker brings an eCompliance terminal to the patient's house and the fingerprint reader verifies the visit. This allows health workers to focus their counseling on patients who miss their scheduled dose the first time, reaffirming the importance of TB drug adherence.

At the end of each day, the eCompliance terminal compresses the daily attendance log into an SMS and sends it to an online SMS gateway. The gateway acts as an online cell phone where messages are viewable in a web browser, decompressed and automatically converted into readable reports. This allows all levels of operational management to view up-to-date information on the TB control program (fig. 1).

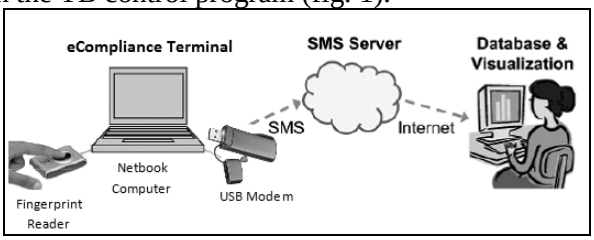

Figure 1

2.2 – Data Security

The eCompliance server is managed by OpASHA's technical staff. Private data is kept only on this secure server, which has undergone an independent SAS 70 audit. Apart from the patient's name and attendance log, patient information is not stored in the terminal. All biometric data remains in the terminal in binary form and deletes automatically after the patient's treatment is completed. Information sent through SMS to the third party SMS gateway uses unique ID numbers and does not contain any private health information.

3. Results of the eCompliance Initiative

OpASHA conducted the eCompliance pilot project in 17 different TB centers with 26 terminals in South Delhi slums and villages. Over 1,400 patients used biometric identification to verify over 60,000 visits and follow-ups. Over the period of a year, the default rate was reduced to nearly 1%, much lower than the Revised National TB Programme's (RNTCP) 6-7% [8].

Interviews with the pilot's health workers reported that eCompliance improved DOTS because patients were more likely to visit the centers themselves instead of sending a friend or relative to collect the medicines. The terminals also helped health workers quickly see which patients had not visited the center, allowing them to call and remind the patient before the missed dose.

In the most populous urban areas (OpASHA's health workers cover an average of 100 patients) the real time attendance logs allowed health workers to keep better track of patients. OpASHA's health workers also found that patients were more likely to visit a center with eCompliance because the technology demonstrated that the program was committed to high quality treatment.

Both patients and health workers commented on the simplicity of the system. Health workers-the primary users of the system- found that the color-coded interface allowed them to navigate easily through the system. They also found that patients had no trouble scanning their fingerprint before taking their medicines. One commented that patients enjoy seeing a photograph of their fingerprint each time they visit the center (fig. 2).

Figure 2

4. Conclusion: The Way Forward

In India, the "RNTCP recognises that implementation of a good quality DOTS programme is the first priority for TB control in the country. Prevention of emergence of MDR-TB in the community is more imperative rather than its treatment" [9]. As the price of technology falls, technological and biometric approaches towards TB control are viable even in poor areas. The current DOTS program allows opportunities to apply novel technological solutions, which have thus far shown significant results in preventing MDR-TB.

eCompliance is that solution and has enhanced and improved the DOTS model. The system has been able to verify that patients were present for treatment by enhancing observation with biometric identification. It provides a method to quickly and systematically respond to missed doses by patients with up-to-date attendance information. Since this is done through SMS instead of an internet connection, eCompliance is functional in resource-limited settings. An automatic follow-up procedure reduces the response time to defaulting patients and focuses counseling on first-time and repeat missed dose patients. Lastly, eCompliance digitizes attendance information and automatically produces reports and analyses of the data.

DOTS is a historical landmark in tuberculosis control and public health, however the strategy has the opportunity for improvement through mobile technology. Enhancements such as eCompliance demonstrate that the TB community will benefit by studying new and best practices in TB control.

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