Abstract—Tuberculosis (TB) continues to be a health risk worldwide and one of the third leading reason for deaths by an infectious disease globally. Although TB is curable, poor compliance to extended treatment routines leads to increased fatality, disease transfer and also drug resistance. Directly Observed Therapy (DOT) is an approach where the health workers or patients need to travel to take their medications which are time consuming and cost ineffective. The proposed Video Directly Observed Therapy (VDOT) is a patient-centered approach for administering the treatment to ensure adherence to medication. VDOT is medication process. VDOT is a less burdensome way of providing DOT remotely via smartphones, that involves patients recording the videos taking their medications which are sent to the VDOT workers for review. This approach helps in maintaining high compliance to medication and is a viable option resulting in effective medication, low mortality rates and reduced risk of disease transmission compared to DOT.

Keywords—VDOT, Tuberculosis, Smartphone, VDOT Worker, Adherence.

I. INTRODUCTION
Tuberculosis is a disease that affects the lungs and is infectious. Compared with other diseases caused by a single infectious agent, tuberculosis is globally, the second biggest killer [1]. Medicine management is one of the important aspects in tuberculosis. One has to undergo proper and regular treatment in order to get rid of this disease completely. Usually the treatment lasts for a longer period of time (6 months to 2 yrs). Most of the TB cases can be cured when the appropriate medication is accessible and dispensed correctly. Antibiotics are often needed to be taken for a longer period of time. Every treatment must be completed, even if the symptoms have declined. Bacteria that survive the treatment, it could become resistant to the medication prescribed and may lead to MDR-TB (Multi-Drug-Resistant Tuberculosis) in due course of time [2]. Skipping the dose might cause a threat to life. DOT is a patient-focused method that is used to observe patients ingesting medication to ensure compliance and achieve completion [3]. But this involves the Healthcare workers or the patients travelling a long distance. The developed project sends reminder to the patients so that medications are not missed, similarly alerts are sent when medications are not taken at the expected time. Data of adherence to timing and reports can be viewed by multiple users (VDOT Worker, Doctor, Health officer) anytime, anywhere as the data is stored on cloud. The patients have to send a video to the VDOT worker showing the consumption of medicine.

II. LITERATURE SURVEY
Pinkser et al. discuss how use of mobile phones in treatment of chronic diseases such as diabetes mellitus showed better results compared to the traditional way of treatment for the same. It was found that using a mobile phone as the patient-terminal had a higher acceptance rate by the patients, which resulted in higher adherence to the treatment [4]. Nyugen et al. discuss the feasibility of Video Directly Observed Therapy for treatment of pulmonary Tuberculosis based on tests carried out in Vietnam. Even though initially, the patients took time to adjust to the technical part of the treatment method, gradually they found it simpler and much more comfortable to use [5]. Gassanov et al. discuss the use of Videophone DOT method to treat patients with active TB. The Toronto Public Health (TPH) used this mode of treatment to treat about 13 patients and further expanded it to 35 patients and found it to be extremely useful and supporting flexibility and privacy [6].

III. OVERVIEW
A. Purpose
The Revised National Tuberculosis Control Program (RNTCP) is the state-run tuberculosis (TB) control initiative of the Government of India. As per the National Strategic Plan 2012–17, the program has a vision of achieving a "TB free India" by 2025 [7]. There are severe limitations in existing tools for TB diagnosis, prevention and its treatment. The therapeutic process lasts at least two years and involves up to 14,600 pills and numerous of injections – which have adverse side effects. Novel
mechanisms are required to reduce the time taken for drug-sensitive TB treatment. In the existing method for treatment known as DOT either the health care worker has to travel a significant distance for home visit to monitor the medication intake of every patient or the patient has to travel to the site of the health care worker every time they take their medication. This method is time-consuming, costly to administer and has the increased probability of transmission of the infectious disease to other people during conveyance. The proposed system is a patient-centered approach for administering anti-tuberculosis treatment ensuring compliance to medication. The purpose of VDOT is to bridge the gap between caregiver and the patient. It helps patients adhere to daily treatment over an extended period of time [8].

B. Product Perspective

The VDOT system consists: 1) An android based application for the patients and 2) a web-enabled client management application for the health care workers (Nurse, Doctor, District Level officer/Chief Medical Officer, Municipal Health Officer, Nodal Public Health authority, etc.). Using smartphone app the patient records videos of each dose of TB medication intake and uploads them to the VDOT system. The health care workers can view and document each by the help of web-based client management application. The VDOT workers will need to check the website regularly and document: 1) the videos received, and 2) ingestion of the prescribed tablets. The VDOT system assists in sending reminders to the patients at the stipulated time of medication intake. If videos are not received at the expected medication time alerts are sent to the patients and their family members as well as their doctors.

IV. METHODOLOGY

Figure 1: Architecture of the VDOT system

Figure 1 illustrates the architecture of the VDOT system. Patients use the android based app to record videos of them taking the medicines. The VDOT system includes an android application for the purpose of recording, transferring and storing videos; and a web-based client management application used by DOT workers to view and report each video. On the client side the application allows the patients to receive the notification sent by the VDOT worker. On receiving the reminder notification the patient will then enter the specific pill number and move on to the recording of the video. The video is then successfully uploaded to the server. The format of the video name will include the patient’s unique id and the date and time when the video is sent. Text message reminders are sent to patients’ phones on a daily basis—one before doses were due and if expected videos are not received. The android application automatically sends encrypted, date/time-stamped videos to a secure cloud server via Wi-Fi or cellular network. If network service is unavailable, videos is stored on the phone till the connectivity is restored. For the purpose of maintaining privacy, videos cannot be viewed on the phone and are automatically deleted after they are uploaded to the system. Uploaded videos are watched by VDOT workers through a website to monitor for compliance. The VDOT workers verify receipt of videos and whether all tablets have been consumed. Suppose ingestion is not properly visible or video is not received the family member are notified. Data of adherence to timing and reports can be viewed by multiple users (VDOT Worker, Doctor, Health officer) anytime, anywhere as the data is stored on cloud. The main advantage of using cloud is accessibility i.e. the files can be
stored remotely and can be accessed from anywhere via internet connection by multiple users.

V. IMPLEMENTATION

The experiments were carried out on:

- Laptop running on Windows 7 or above operating system, with a RAM of 2 GB and above, having Pentium processor or above.
- Android phone with minimum version 4.3.

The Software used for implementation are as follows:

- Eclipse 4.4.1: Eclipse is an integrated development environment most commonly used to create an android application using Android Java as the programming language.
- WampServer 2.5: WampServer is used to maintain the database and the server for storing videos and other information. It has the following components:
  - The Apache HTTP Server
  - OpenSSL
  - MySQL
  - PHP
- Microsoft Visual Studio 2010: Microsoft Visual Studio is an IDE from Microsoft used to create the website for this project
- .NET Framework: .NET is an open source, cross-platform, freely available developer platform for building various kinds of applications.
- Visual C#: C# is an object-oriented, modern, general purpose programming language for developing the website.

Figure 2 to 7 illustrates snapshots of the android application:

![Figure 2: Splash screen of android app]
![Figure 3: Login page]
![Figure 4: Page to enter pill number]
![Figure 5: Start video recording]
![Figure 6: Stop video recording]
![Figure 7: Video uploaded successfully]

Fig 8 to 18 illustrates the snapshots of the website:
Each healthcare worker can view a summary of the patients under them. The VDOT worker and the Doctor can view a particular patient’s details, along with his/her Doctor’s or VDOT worker’s name respectively and the Municipal Health Officer’s name, the number of videos received on time and number of videos delayed as displayed in Figure 16 and 17 respectively.

The Municipal Health Officer can view the details of all the patients in his region as displayed in Fig 16 and 17 respectively.

The limitations of the proposed project are as follows:

- It requires a Smartphone with Video recording capability.
The proposed system requires internet access on both the application as well as the website. Also it requires a good and stable network connection at the client side (application) in order to upload the videos of medication intake.

If the internet connection is poor then the videos will not be uploaded successfully and may result in delay and false documentation.

VII. CONCLUSION AND FUTURE WORK

Smartphone technology is playing a crucial role in healthcare; VDOT has abundant prospective to broaden the coverage of monitoring the TB treatment to many patients across the globe by decreasing the stress on both patients and healthcare workers. This results in better treatment achievement rates, lesser new cases of TB, and stoppage of multi drug resistant TB. VDOT can also be used to observe various health conditions which require adherence to strict medication. Infected persons need not travel to the health care center to confirm intake of medication. Similarly, health-care workers need not travel to the location of each infected person to observe adherence to medication intake. This helps to eliminate travel time (for both health care worker and the infected person), reduce cost and reduce chance of transmission of the disease during transit by the infected person (coughing, sneezing or talking) to show compliance to timing of medication consumption. The proposed approach requires internet connection to send videos, a method to transmit videos without internet can be considered as a scope for future work.

References


