

Preliminary Design of a Community Telemedicine System for Tuberculosis Control

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Abstract— More than eight million people develop active tuberculosis (TB) every year, and about two million die, with more than 90% of global TB cases and deaths occurring in the developing world. DOTS, a program to control TB based on diagnosis and treatment of infectious cases and incorporating the essential management tools has been promoted by WHO as a global strategy since the mid-1990s. While countries applying DOTS on a wide scale have witnessed remarkable results, most developing countries have been unable to expand DOTS as rapidly as needed. Several reasons cited include poor health system organization and TB managerial capability, poor quality and irregular supply of anti TB drugs, and lack of information.

This paper describes the preliminary design for a community telemedicine system as an aid in TB treatment and surveillance management, especially in developing countries. The design aims to provide an integrated information system framework to assist TB treatment in accordance to DOTS. It will include software modules for (i) patient treatment surveillance data recording and reporting, (ii) general epidemiology & statistical data recording & reporting, (iii) case finding, diagnostic tool & laboratory examinations, (iv) medication-and-supplies inventory and distribution, (v) personnel training as well as (vi) community education & environment conditioning.

The system will use on-location existing telecommunication networks (i.e. internet, GSM, phone line, according to location availability) and telemedicine would be utilized for transfer of healthcare report data, telediagnosis, management of medication distribution and teleeducation. We expect to conduct pilot experimentation in cooperation with the Bandung local health office and Community Health Centres, which are also implementing the DOTS program. In the future, it is hoped the information system can also be a template to develop similar integrated systems for other health issues (i.e. other disease treatment, management of outbreaks, disaster, and other healthcare issues).

Keywords— telemedicine, information system, Tuberculosis, DOTS

I. BACKGROUND

More than eight million people develop active tuberculosis (TB) every year, and about two million die, with more than 90% of global TB cases and deaths occurring in the devel-

oping world. High-burden countries identified in 2003 were: Afghanistan, Bangladesh, Brazil, Cambodia, China, DR Congo, Ethiopia, India, Indonesia, Kenya, Mozambique, Myanmar, Nigeria, Pakistan, Philippines, Russian Federation, South Africa, Thailand, Uganda, UR Tanzania, Viet Nam and Zimbabwe. Indonesia itself contributes to approximately 10 percent of the world's Tuberculosis case. (1) DOTS, a program to control TB based on diagnosis and treatment of infectious cases, incorporating essential management tools has been promoted by WHO as a global strategy since the mid-1990s. The five components of DOTS are (1):

1. strong political commitment and sustained resources
2. accurate diagnosis through smear microscopy
3. standardized six- to eight-month treatment regimens with directly observed treatment for at least the first two months
4. a regular, uninterrupted supply of all essential medicines
5. standardized monitoring, recording, and reporting systems.

While countries applying DOTS on a wide scale have witnessed remarkable results, most developing countries have been unable to expand DOTS as rapidly as needed. Several general obstacles in implementing DOTS cited, including in Indonesia, include:

- poor health system organization and TB managerial capability, i.e.
 - poor monitoring and evaluation systems
 - ineffective decentralization of healthcare system
 - lack of coordination with private practitioners and other public providers of TB care services
- lack of qualified staff
- poor quality and irregular supply of anti TB drugs and weak laboratory support,

Lessons learned from implementation indicates that while DOTS is indeed essential for TB control, the original 5 elements of DOTS alone can be improved on to control TB globally (1). New strategies from local experiences and adaptations should be utilized and incorporated to the DOTS strategy to help overcome TB-Control issues.

The new Stop TB Strategy (1) (The STop TB STRaTegy, Building on and enhancing DOTS to meet the TB-related Millennium Development Goals, WHO,2006) has been developed as a response to above challenges in DOTS implementation. It includes the following essential elements:

1. Pursue high-quality DOTS expansion and enhancement
2. Address TB/HIV, MDR-TB and other challenges
3. Contribute to health system strengthening
4. Engage all care providers
5. Empower people with TB, and communities
6. Enable and promote research

To conduct an optimal implementation of DOTS and the Stop TB Strategy , a comprehensive support system customized to each implementation point (country or sub-country level) that can cater to all aspects of DOTS effectively and utilizes the available resources appropriately is needed.

This paper describes the preliminary design for a community telemedicine system as an aid in TB treatment and surveillance management, supervision, and quality control, especially in developing countries. The design aims to provide an integrated information system framework to assist TB treatment in accordance to DOTS and the new Stop TB Strategy.

II. SYSTEM DESIGN

The design aims to provide an integrated information system framework to assist TB control in accordance to DOTS and the new Stop TB Strategy. Correlation between the design concept with the DOTS and new Stop TB Strategy can be seen in table 1 and 2. The system consists of the following software modules:

- i) Patient treatment surveillance data recording and reporting module. This module would be placed on primary points of care such as Community Health Centers, private medical doctor practices (when possible) and hospitals. It consist of a PC-based electronic medical record system for TB patients, equipped with patient treatment management and reminder functions (including SMS-based system for medication and visit reminder), and a medical teleconsultation function for medical referrals of patients to relevant specialists in other locations.
- ii) General epidemiology & statistical data recording & reporting module. This module consists of the data collection nodes (points of healthcare services) and the data-bank server to be placed in the relevant health offices and their referrals. The data collection nodes

processes data from the patient data recording and reporting module and automatically generate formatted reports according to existing health procedures. The report data are periodically sent to the appropriate referral health office via the internet or other modes of communication. The data-bank server component gathers and organize the data from various data collection nodes and arrange them into a comprehensive database. This module should also be equipped with relevant statistical/epidemiology and data mining functions.

- iii) Case finding, diagnostic tool & laboratory examinations module. This module functions as a telemedicine system that facilitates transfer of sputum images to laboratory facilities. It is also equipped with image processing software for diagnostic tools to help reduce the rate of error in laboratory examinations
- iv) Medication-and-supplies inventory and distribution module
The system would provide a drug supply, distribution and management information system integrated to the treatment information system
- v) Personnel training, community education & environment conditioning module

This module consists of a comprehensive information package which includes training modules, community education website and web forum, as well as presentation and printable materials for socialization activities.

Table 1 Correlation between the DOTS Strategy and The System Design

DOTS	System Implementation
Political Commitment	Data and information gathered comprehensively can aid in appropriate decision making, budgeting and other political commitment activities
Microscopic Sputum Examination	Telemedicine system facilitating transfer of sputum images can reduce the rate of error in laboratory examinations
Direct observation of treatment	The system would provide an electronic medical record system whenever appropriate for implementation Medication reminder applications can be implemented via SMS-based systems whenever appropriate
Monitoring & Evaluation	The system would provide an automated report generation function with indicator analysis facilities for program monitoring and evaluation
Adequate supply and quality of medication	The system would provide a drug supply, distribution and management information system integrated to the treatment information system

Table 2 Correlation between the New Stop TB Strategy and The System Design

New Stop TB Strategy	System Implementation
Pursue high-quality DOTS expansion and enhancement	(See table 1)
Address TB/HIV, MDR-TB and other challenges	<ul style="list-style-type: none"> The system would establish a more organized record for MDR Implementation in high-risk groups
Contribute to health system strengthening	The software modules would provide a means to establishing health system aspects, i.e. reporting and recording procedures, referral system, monitoring and other functions
Engage all care providers	<ul style="list-style-type: none"> The system would be implemented in both governmental and other private healthcare providers. Specialized applications can be provided for each type of healthcare providers (for example: PC-based systems for Hospitals and government healthcare providers, SMS-based systems for start-up implementation in private medical doctors) The system will be designed to comply to the International Standards for Tuberculosis Care (ISTC)
Empower people with TB, and communities	The system should facilitate the process of: <ul style="list-style-type: none"> Combining the implementation of healthcare with other community services Advocacy, communication and social mobilization for community participation in TB care and combating stigma and discrimination
Enable and promote research	The data gathered from the system database can be more readily processed for research applications

III. IMPLEMENTATION SCHEME DESIGN

We expect to conduct pilot experimentation in cooperation with the Bandung local health office and Community Health Centres, which are also implementing the DOTS program. The system will use on-location existing telecommunication networks (i.e. internet, GSM, phone line, according to location availability) and telemedicine would be utilized for transfer of healthcare report data, teleradiology, management of medication distribution and teleeducation. The system implementation scheme block diagram can be seen in figure 1.

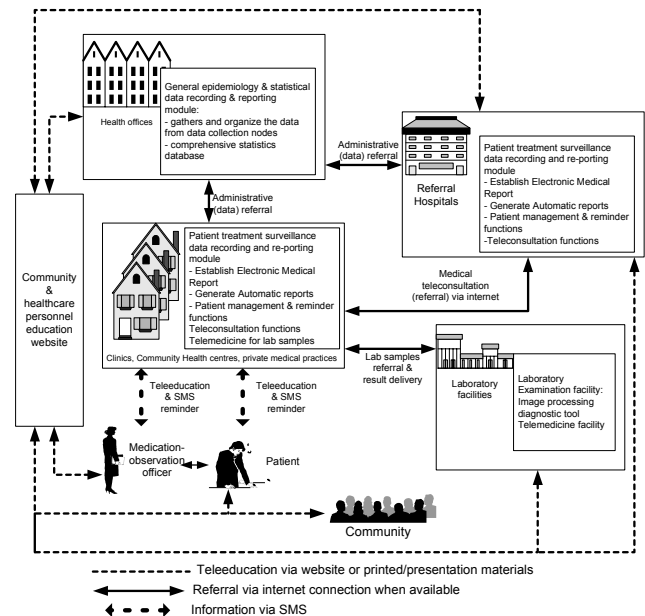


Fig. 1 System Implementation Scheme Block Diagram

IV. DISCUSSION

A. Implementation Issues

The system designed would be implemented in locations with different characteristics and needs, thus there are several key issues which needs to be taken into consideration in implementation. These issues include:

- Implementation node facility, infrastructure, human resource and need analysis
- Involvement of local civil figures in advocacy and socialization
- Socialization and advocacy to promote community involvement, which include community education on TB, medication observation participation and other forms of participatory activities
- The use of traditional methods to administer service and disseminate information should not be ignored

B. Further System Development and Expansion

As a starting point, this preliminary design covers only telemedicine and information system applications that can be most straightforwardly applied to aspects of TB control. Potential development/expansion can incorporate other functions or aspects of TB control into the system, such as relation with other healthcare programs (HIV, PAL, and other applications), program relation to

other community service functions (education, poverty reduction, telecenters application) and other possible applications.

In the future, it is hoped the information system can also be a template to develop similar integrated systems for other health issues (i.e. other disease treatment, management of outbreaks, disaster, and other health-care issues).

V. CLOSING REMARKS

It is hoped that the design can be realized and implemented in a pilot application appropriately in day-to-day healthcare. Results from the research can be submitted as a recommendation to the RI Department of Health for expanded implementation

It is hoped that the proposed community telemedicine system configuration for TB control will be able to posi-

tively contribute to the efforts in controlling TB, especially in Indonesia and other developing countries.

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