
Original Paper

Web-based Tools Help Fight TB in Taiwan

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Abstract

Background: Among communicable diseases, tuberculosis (TB) is a leading cause of death worldwide, killing 2 million people each year. TB in Taiwan is a major public health issue as well. In 2004, the mortality and incidence rates of TB in Taiwan were 4.2 and 74 per 100,000 population, respectively. Compared to the TB mortality and incidence rates in the United States (0.5 and 5 respectively) and Japan (4 and 30 respectively) in 2004, there is much room for Taiwan to improve TB control. A major system redevelopment project in 2001 marked the beginning of a continuous effort in converting the existing system to be web-based. Web-based modules developed to-date include case notification, case management for hospital personnel, automatic indicator-based monitoring of total quality management, automatic alert via cell phone to designated health officials, management of medications, and online professional development.

Objectives: The objective was to evaluate a web-based National TB Register system designed for health care professionals to report accurate, timely and reliable data as part of TB surveillance and case management.

Methods: The performance of this system was evaluated in terms of improvements in follow-up of TB treatment cohorts and the compliance of notification timeliness.

Results: The enhancements have resulted in significant system usage. Currently, this system is used by 832 institutions, 5128 individuals in Taiwan with an average of 210,000 logins annually. With implementation of internet tools, improvements in the following areas have been observed: (i) the trend for the reduction of defaulted and transferred out patients in 2001-2003 treatment cohorts, (ii) the trend for the increase of compliance of notification timeliness (34% in 2001, 84% in 2002, and 99% in 2003, $P < .0001$).

Conclusions: TB surveillance and case management involve a large number of specialized personnel and public health agencies. While Internet-based tools have been shown to effect improvement in TB outcome, it is a major challenge, from a system development of view, to understand users' requirements and to build a consensus among all users as to what tools and associated priorities need to be developed.

KEYWORDS

Tuberculosis; Internet; disease notification; management information systems

Introduction

Infectious diseases remain the largest cause of death in the world, and among infectious diseases tuberculosis (TB) is responsible for the greatest number of deaths [1,2]. World wide there were approximately 9 million new TB cases and 2 million TB deaths in 2004 [3]. Although the African region has the highest estimated incidence rate (356 per 100000 population per year), the majority of TB patients live in Asian countries, including India, China, and Indonesia.

Taiwan is an island in East Asia with high population density (about 22.8 million people/36000 square kilometers) [4]. A fast growing economy since the 1980's, with an increasing number of foreign brides and foreign laborers, and a booming tourism business, coupled with the current epidemic of human immunodeficiency virus infections associated with injection drug users makes TB control a real challenge for Taiwan [5].

From 1950 to 1960 in Taiwan, the annual incidence of TB was high; for example, in 1957 there were 5150 cases per 100000 population, but by 1970's, the incidence rate had decreased to 30 – 40 per 100000. However, the following 20 years, the incidence rates increased gradually [6] so that in 2004, the incidence of TB had increased to 74 cases per 100000. In comparison, the TB incidence rates in the United States, Japan, Hong Kong, and Viet Nam in 2004 were 5, 30, 75, and 176, respectively [3].

Though TB has been one of the major causes of death in Taiwan for decades, its mortality rates have decreased over time. For example, in 1953 TB was ranked the 3rd highest cause of death compared to 2004 when it was listed only as the 13th cause with 4.2 deaths per 100000 population [6,7]. By contrast, the TB mortality rates in the United States, Japan, Hong Kong, and Viet Nam in 2004 were 0.5, 4, 6, and 22, respectively [3]. Although TB control in Taiwan is improving, it is still behind developed countries.

An early attempt at monitoring the effectiveness of TB control measures was a computerized National TB Register. This registration process was developed in 1994 and included a client-server computer program, within a registration network [8]. With the establishment of the Register, public health nurses, in each local health unit, were responsible for entering the data of reported TB cases into the system to assist in case management. In March 1995, when the Bureau of National Health Insurance (BNHI) was established it became possible for all the TB patients to be diagnosed and receive their anti-TB medications in any clinic or hospital in Taiwan. This accessibility was a significant improvement over the previous system where TB patients could only be diagnosed and receive treatment at designated hospitals in Taiwan that specialized in the treatment of TB. Although notification of TB cases was mandatory in Taiwan, however, at this point in time, underreporting, due to various reasons, by health care providers was not unusual. To address this problem, in July 1997, BNHI introduced no-notification-no-reimbursement and the notification-fee policies for TB patients [8]. As a result of these measures the TB reporting rates increased. However, this initial

monitoring was limited to very few users and a private network, and, as numbers increased could not meet the demands for improving surveillance and case management. In response to these increased demands, a user-friendly web-based National TB Register was launched by Taiwan Center for Disease Control (Taiwan CDC) in November 2001. This study seeks to investigate the impact of the web-based tools on TB surveillance and case management in Taiwan, especially evaluating the performance in terms of effects on follow up and compliance with notification timelines.

Methods

Overview of System

The system being evaluated is an automated, integrated case record and notification system which not only alerts health authorities, but also supports health care professionals in providing treatment, tracking cases and case contacts, following up case status, managing cases, generating statistics and epidemic reports, arranging referral services, implementing quality management and monitoring the directly observed treatment short-course (DOTS). This system also generates information related to medical insurance, health care resources, TB related acts and regulations, TB education materials and generally serves as a single comprehensive source for all system users [9].

TB Case Notification

While health care providers always have the option of mailing or faxing their written notification, this system enables them, with user identifier and password protection, to directly input data on the web meeting the requirement of reporting all new cases, suspected or confirmed, to health authorities within one week.

In addition to monitoring individual cases, this system also has the capacity to monitor groups with higher incidence rates, such as seniors, foreign laborers, those living in remote areas, aboriginal people and health care workers. To prevent potential outbreak, when cases of these groups are identified, cell phone messages are generated automatically to alert officials at Taiwan Center for Disease Control and local health authorities.

Within two days following initial notification, the health authority staff confirms and registers. The system then assigns a unique case number. The local health unit where the patient lives can then perform case management activities. Each case is assigned to a specific public health nurse.

Once created, the individual record is used to track case status, monitor treatment and link to diagnostic test results. Summary statistics, by age, gender, geographic areas, treatment outcome and time period, can be generated.

Case Demographics

The Personal Identification Number (PIN) is used for each new case when first reported and registered. This PIN, together with reporter information, is needed to input case demographics, including such data fields as name, address, telephone number, date of birth. Patient demographic information is accessed by authorized health care providers.

The system is also able to incorporate case contact information for each case too. This feature allows public health professionals to track high risk cases and find possible latent TB infection (LTBI) cases.

Case Management

By using the PIN, users can track the status of each case, including case admission, contact status, DOTS implementation and visiting log, follow-up, laboratory test results, case information update, case closure, physician committee audit, and relapsed cases.

In addition to the monitoring of individual cases the system is designed to assess the current status of entire special high risk groups such as aboriginal people as noted earlier.

Total Quality Management (TQM) Protocols

Strict system protocols are necessary to support TB surveillance and case management which is a complex and comprehensive process. Total Quality Management tools are used to further enhance the evaluation of data entered into the system. These system features include:

1. Automatic validation of case PIN
2. Automatic matching of case PIN with that of known physician, nurse to generate automatic cell phone message to related health personnel
3. Automatic case assignment to local health authorities
4. Online assistance for TB public health nurses
5. Automatic feedback to system users
6. Linkages to the medical insurance plan, health care institutions and public health system

The system also provides comprehensive TQM reporting tools for system users. For example, for case notification and registration, system users could query and automatically flag those cases:

1. Having greater than 7 days from preliminary diagnosis to notification

2. Where notification has taken place, but the case is not yet registered
3. With abnormal or unknown case PIN number

The system can also generate reports based on indicators recommended by the World Health Organization (WHO), for example, the case treatment success rates and the standardized mortality rates. For health care institutions and physicians, the system also flags those cases that have been reported and registered but have not been closed within a specified period, for example, 6, 9, 12 and 18 months.

Security, Privacy and Confidentiality

Security is an important component of this system. With a confidentiality agreement, qualified users are granted system access. Job related responsibilities and needs define the level of access which is reviewed on a regular basis.

Results

The redevelopment of Taiwan CDC's National TB Register to a web-based system provides enhanced access by health care providers and public health practitioners, wherever Internet is available, resulting in a higher level of sharing of TB surveillance and case management information. In 2005, the system had 5128 individual authorized users, 832 authorized organizations, and 210000-230000 queries each month. More than 3000 physicians used this system to care for TB patients.

Analysis of treatment outcomes for registered TB cases in the 2001-2003 cohorts (the most current data available -Table 1), the trend for the proportion of defaulted and transferred out cases both decreased significantly (both $P < .0001$ in Cochran-Armitage Trend Test [10]).

Compliance of notification within 7 days for all newly suspected and confirmed TB cases increased from 34% in 2001 to 84% in 2002 and to 99% in 2003 ($P < .0001$).

Table 1. Treatment outcomes for registered TB cases (2001-2003 cohorts)

Year	Successful (%)	Failed (%)	Died (%)	Defaulted* (%)	Transferred out* (%)	Total
2001	10422 (74)	51 (0)	2832 (20)	728 (5)	86 (1)	14119
2002	12882 (78)	62 (0)	2918 (18)	519 (3)	62 (0)	16443
2003	11207 (79)	56 (0)	2651 (19)	238 (2)	34 (0)	14186

*Defaulted: a patient's treatment was interrupted for 2 consecutive months or more.

*Transferred out: a patient who transferred to another reporting unit and whose treatment outcome is not known.

Taiwan, located in a region with high incidence of TB, has invested substantial resources in the surveillance, reporting and management of TB. The system redevelopment described in this paper incorporated effective web-based tools that have shown positive impact on TB control in Taiwan.

The assignment of each TB case to a specific public health nurse assisted by the web-based system reduces the number of defaulted and transferred out patients in 2001-2003 treatment cohorts and the TQM reports of the system greatly improve the level of compliance of timely notification. The lesson learned

is that easier system access, effective case reporting and management tools not only provide better data, but also free up health care professional to focus on clinical aspects of TB treatment and control. User feedback regarding the previous system helped to better reflect the operational workflow of TB surveillance and case management.

On the 2005 World Health Day, Taiwan CDC announced a national action plan aiming to reduce TB incidence by 50% in ten years; that is, from about 15000 new cases each year to 7500. The belief is that the web-based National TB Register

can meet the challenges of this ambitious campaign. Further system enhancement will continue to ensure new technology such as wireless data transmission is fully exploited in fighting TB in Taiwan. The experience gained from this system project

is also beneficial in our continued efforts in developing surveillance and reporting systems for communicable diseases.

In conclusion, the web-based National TB Register has demonstrated measurable benefits in supporting TB control in Taiwan.

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Conflicts of Interest

None declared

References

1. Dye C. Global epidemiology of tuberculosis. *Lancet* 2006;367(9514):938-940. Medline:16546542
2. WHO. The World Health Report 2004: Changing History. Geneva: World Health Organization; 2004.
3. WHO. Global Tuberculosis Control: Surveillance, Planning, Financing. WHO Report 2006. Geneva: World Health Organization; 2006.
4. Directorate-General of Budget, Accounting and Statistics, Executive Yuan, R.O.C. National Statistics. URL: <http://eng.stat.gov.tw> [accessed 2006 Jun 11] Webcite: 5GYWiyWXq.
5. Taiwan CDC. 2005 Annual Report. Taipei: Center for Disease Control, Taiwan; 2005.
6. Hsueh PR, Liu YC, So J, Liu CY, Yang PC, Luh KT. Mycobacterium tuberculosis in Taiwan. *J Infect* 2006;52(2):77-85. Medline:16216328
7. Department of Health, Executive Yuan, R.O.C. Leading causes of death, Taiwan area. URL: <http://www.doh.gov.tw/statistic/english/2/1.xls> [accessed 2006 Jun 11] Webcite: 5GYolALTs.
8. Chiang CY, Enarson DA, Yang SL, Suo J, Lin TP. The impact of national health insurance on the notification of tuberculosis in Taiwan. *Int J Tuberc Lung Dis* 2002;6(11):974-979. Medline:12475143
9. Liu CT, Hsieh MJ. Comparative analysis of tuberculosis surveillance management and information systems in Canada, America and the West Pacific Countries. Taipei: Taiwan Center for Disease Control; 2005. Report No.: DOH94-DC-S9405.
10. Margolin BH. Test for Trend in Proportions. In: Kotz S, Johnson NL, editors. *Encyclopedia of Statistical Sciences*. New York: John Wiley & Sons, Inc.; 1988: 334 - 336.