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Intervals Before Tuberculosis Diagnosis and Isolation at a Regional Hospital in Taiwan

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Background/Purpose: Nosocomial tuberculosis (TB) infection is still a problem in many Taiwanese hospitals. The objectives of this study were to explore the intervals before TB diagnosis and isolation at a regional hospital in Taiwan, and to provide useful knowledge to hospitals for the purpose of TB infection control.

Methods: From 2002 to 2005, we included a total of 343 patients with culture-positive pulmonary TB in a regional hospital in Southern Taiwan for this study. Their medical records were reviewed, and the time intervals between patient-hospital contact points and isolation were recorded.

Results: Of 343 culture-positive pulmonary TB patients, the majority were male, over 40 years old, and unemployed. The mean interval between the first admission and isolation was 20.5 days (median, 2.0 days). The mean intervals between the first admission from outpatient clinics, emergency department and hospitalization and suspected TB were < 1 day, 6.07 days and 25.53 days, respectively. The mean accumulated exposure time was 0.35 days, 0.61 days and 10.09 days in outpatient clinics, the emergency department and hospitalization, respectively; 75.5% of patients had their diagnosis confirmed at the chest department of the department of internal medicine.

Conclusion: Delayed diagnosis was most likely in the case of hospitalized patients and least likely in outpatient clinics. Delayed diagnosis in hospitalized patients also contributed more severely to TB exposure time than others. Enhancing the quality, speed and ability of specialists and physicians to diagnose TB, especially in emergency departments and in hospitalized patients, is essential. [*J Formos Med Assoc* 2007;106(12):1007–1012]

Key Words: infection control, interval, nosocomial infection, pulmonary tuberculosis, Taiwan

After the SARS (severe acute respiratory syndrome) outbreaks in 2003, nosocomial infection has become an important issue in Taiwan's hospitals. Some outbreaks of nosocomial tuberculosis (TB) infection were noted in several large hospitals and proved by biomolecular techniques.¹ Therefore, the issue of nosocomial TB attracted the

attention of the public. Especially, there were closed and central air-conditioning systems in most hospitals, most of which were experiencing increasing numbers of patients. TB remains a widespread infectious disease and is the most common notifiable communicable disease² in Taiwan. The notification rate of confirmed TB was 70–80

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Received: May 9, 2007

Revised: May 28, 2007

Accepted: September 4, 2007

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cases per 100,000 population. The high prevalence in the community caused an increase in the risk of nosocomial TB transmission in healthcare facilities.

The incubation period of pulmonary TB, a contagious disease transmitted by aerosols containing *Mycobacterium tuberculosis*,³ is highly variable and ranges from weeks to decades. Since rapid microbiologic diagnosis of pulmonary TB remains implausible, it is not uncommon for the diagnosis of TB to be heavily reliant on the clinical experience of healthcare givers. Therefore, there were a number of misdiagnoses or delayed diagnoses in cases of pulmonary TB and transmission potential, especially when patients were treated by inexperienced physicians. In such a clinical setting, these undiagnosed cases expose anyone at those hospitals to *M. tuberculosis*-containing aerosols, with a subsequently greatly increased risk of infection. The risk of nosocomial TB was substantial, especially if immunocompromised patients inhaled these contagious aerosols.⁴

The most important infection control practice for clinical management of cases with pulmonary TB in health care settings is the prevention of *M. tuberculosis* transmission, or the prevention of nosocomial TB outbreak.⁵⁻¹³ It has been recognized that if the time interval from hospitalization to isolation of infectious pulmonary TB patients is more than 5.5 days, then healthcare workers will have an increased risk of TB infection.¹⁴ Likewise, Stroud et al found that in a case of nosocomial TB, the median interval before isolation was 6 days.¹⁵ Theoretically, a decrease in the time interval between admission and respiratory isolation among cases with smear-positive pulmonary TB can decrease the probability of TB transmission in hospitals. If the elapsed time can be shortened to 2 days, it is possible to prevent the transmission of *M. tuberculosis*.¹⁵

Therefore, it is important to determine the real situation of TB control in Taiwan's hospitals. The objectives of this study were to explore the indices of nosocomial TB infection at a regional hospital in Taiwan, and to provide useful strategies for TB infection control for hospitals.

Methods

The study hospital, a regional hospital, is located in Southern Taiwan. It has approximately 1000 beds, 2150 employees, and >40 specialized departments. There are >3000 patients everyday in the outpatient clinics, >280 patients everyday in the emergency department, and 25 negative-pressure beds available for respiratory isolation.

From 2002 to 2005, patients who were newly diagnosed with pulmonary TB infection with positive cultures in this hospital were included in our study. Pulmonary TB with positive culture was defined as a person who showed bacteriologic evidence of TB disease attained by sputum culture.

Five infection control nurses were trained as investigators. The medical charts of patients with culture-positive pulmonary TB were reviewed by these trained nurses. We collected the following patient information: demographic data, occupation, medical history, specialty of the attending physician, and the details of specific procedures or events (including visits to outpatient clinics or emergency department, hospitalization, and respiratory isolation, initial clinical suspicion of TB, sputum microbiologic surveys, available microbiologic results, and prescription of anti-TB medications). The timing of clinical suspicion of TB was defined as the earliest day and time with the coding of IDC-9-CM #011 as the diagnosis, or as the earliest day and time of medical orders of sputum acid-fast stains or anti-TB medication in medical charts if there was a lack of TB diagnosis records.

The intervals between patient-hospital contacts and respiratory isolation were recorded. The accumulated TB exposure time was defined as the accumulated period in the hospital for patients with pulmonary TB infection before respiratory isolation in negative-pressure single rooms. Such clinical information about patients admitted from the outpatient clinic or emergency department, or those hospitalized for medical illnesses other than for their respiratory symptoms, were compared.

Statistical analysis

Statistical analysis was performed using STATA version 8.0 (StataCorp LP, College Station, TX, USA) and Microsoft Office Excel 2003. The χ^2 test was used to determine the association of categorical variables. A *p* value of less than 0.05 was regarded to be statistically significant.

Results

A total of 343 patients with culture-positive pulmonary TB were included. Their mean age was 62.8 years, with a range of 2–95 years. The majority were aged 61–80 years (43.5%), and 1.8% were younger than 20 years. The majority of patients were male, with a male-to-female ratio of 3.2. The majority (69.0%) of the 343 patients were unemployed. About one third had a smoking history, and 91 (26.5%) had diabetes mellitus (Table 1).

Intervals between patient-hospital contacts and respiratory isolation

The intervals between various clinical events are shown in Table 2. In the table, the case numbers are variable because we calculated only the effective study population. Among patient-hospital contacts, the longest interval was between the first day of admission and clinical suspicion of

pulmonary TB infection (mean, 9.5 days). The mean total interval between the first day of admission and respiratory isolation was 20.5 days (median, 2.0 days).

Table 1. Clinical characteristics of 343 patients with pulmonary tuberculosis

	<i>n</i> (%)
Age (yr)	
≤20	6 (1.8)
21–40	44 (12.8)
41–60	81 (23.6)
61–80	149 (43.5)
≥81	59 (17.2)
Missing data	4 (1.1)
Gender	
Male	260 (75.8)
Female	82 (23.9)
Missing data	1 (0.3)
Occupation	
Unemployed	235 (69.0)
Employed	76 (22.0)
Missing data	32 (9.0)
Smoking	
Yes	119 (35.0)
No	224 (65.0)
Diabetes mellitus	
Yes	91 (26.5)
No	252 (73.5)

Table 2. Mean interval between patient-hospital contact and respiratory isolation among patients with pulmonary tuberculosis (TB)

Interval	<i>n</i>	Mean (d)	Range
The first day of admission to clinical suspicion of TB	341	5.3	0.17 hr – 453.2 d
The day of clinical suspicion of TB to the order for acid-fast sputum stains	340	1.7	–40.0 d – 365.0 d
The day of order of acid-fast sputum stains to sputum collection	337	3.6	0.17 hr – 194.0 d
The day of sputum collection to reporting results of acid-fast sputum stains	335	4.3	0.3 hr – 365.3 d
The day of reporting results of acid-fast sputum stains to initialization of anti-TB drugs	148	8.5	0.1 hr – 732.3 d
The first day of admission to respiratory isolation	133	20.5	0.5 hr – 453.2 d

Table 3. Interval and accumulated tuberculosis (TB) exposure time in outpatient clinics, emergency department and hospitalization

	Mean time interval or accumulated time per person (d)	n
Interval between first day of admission and clinical suspicion of TB infection		
Patients from outpatient clinics	<1	152
Patients from emergency departments	6.07	155
Patients from hospitalization	25.53	34
Mean	5.33	341
Accumulated TB exposure time		
Outpatient clinics	0.35	104
Emergency department	0.61	116
Hospitalization	10.09	80

Suspected intervals and accumulated TB exposure time in outpatient clinics, emergency department and hospitalization

As shown in Table 3, the mean interval between first admission and suspicion of TB was the longest (25.5 days) in the first admission from hospitalization and was shortest (0.07 days) in the first admission from outpatient clinics. The average accumulated TB exposure time was longest during hospitalization (6.06 days per person) and shortest at outpatient clinics (0.27 days per person).

Attending physicians who diagnosed patients were primarily specialists in pulmonary TB

The department of chest medicine (259, 75.5%) was the major clinical division from which doctors made the diagnosis of pulmonary TB, followed by the department of infectious diseases (13, 4%). About 20% of patients were diagnosed by physicians of other specialties (Table 4).

Discussion

In this study, the age distribution of patients with culture-positive pulmonary TB was similar to that of national data reported by the Taiwan Centers for Disease Control.² However, the male to female ratio was slightly higher than the national data

Table 4. Clinical departments that confirmed tuberculosis diagnosis

Clinical department	n (%)
Chest	259 (75.5)
Infection	13 (3.8)
Gastrointestinal	21 (6.1)
Metabolism	10 (2.9)
Others	40 (11.7)

(3.2 vs. 2.2).² The majority of patients in the present study were unemployed. This ratio may also be related to the elderly making up the majority of these patients. One third of patients had a smoking habit, and the correlation between pulmonary TB and smoking needs further investigation. Diabetes mellitus was present in about one fourth of patients, and it was also another issue to be accounted for.

When the intervals between patient-hospital contacts and respiratory isolation were evaluated, the clinical pathways in diagnosis or treatment of pulmonary TB were complicated, and were sometimes outside of the Taiwan Centers for Disease Control guidelines.¹⁶ Every effort was made to clarify any process between patient first admission and isolation (including first day of admission, clinical suspicion of TB, order for acid-fast sputum stains, sputum collection, reporting

results of acid-fast sputum stains, initiation of anti-TB drugs, and respiratory isolation). However, a few cases were beyond the clinical pathways, and were managed by physicians' judgment.

The mean interval between the first day of admission and respiratory isolation was 20.5 days (Table 2). In other words, it took 3 weeks on average for culture-positive pulmonary TB to be identified in patients and isolated in negative-pressure rooms from the time patients visited the hospital for medical help. The median interval between the first day of admission and respiratory isolation was 2.0 days; there was a large difference between the mean and median. The medians of these intervals were much less than the mean and closer to zero. The wide range of data may have been the cause of the large difference. It also revealed that the majority of these intervals were less than 2 days. It is not clear whether the interval was acceptable or not. Among patient-hospital contacts, the longest interval was between admission and clinical suspicion of TB. It means that during the clinical pathway of TB patient management, early detection or identification of TB was a challenge. Other intervals described in this study were first reported in Taiwan and they were, to some degree, different from those of other countries.¹⁷⁻²⁰ More investigations at other hospitals are necessary to figure out the general picture of the effectiveness and efficacy of TB infection control programs, and thereafter these results found in these investigations should become the fundamental background for policy-making in the prevention of nosocomial TB.

The most striking finding of our study was that both suspected intervals and accumulated TB exposure time in outpatient clinics, the emergency department, and hospitalization led to the same conclusion (Table 3): hospitalization takes the longest time and outpatient clinics take the shortest time. In other words, delayed diagnosis of pulmonary TB occurred most often in hospitalized patients and led to the longest accumulated TB exposure time. Patients in outpatient clinics were least likely to experience delayed diagnosis and had the least accumulated exposure

time. The results also revealed that if there was delayed diagnosis in hospitalized patients, it would lead to a greater risk of nosocomial TB infection than in other patients.

Elderly patients were hospitalized with a variety of chronic diseases with complicated symptoms, which often made it difficult for physicians to determine what the major problems were. These patients might have been hospitalized in other departments for other symptoms. If the patients were admitted to a non-internal medicine department, the physicians often just focused on diseases in their specialty and did not consider the risk of TB infection. The clinical diagnosis of pulmonary TB was often made by staff from the department of chest medicine (Table 4). Most likely, the physicians that patients encountered during hospitalization or in the emergency department were not chest physicians, but rather physicians of other specialties or even non-specialized resident physicians. The quality of TB diagnosis was dubious. Therefore, enhancing the quality of TB diagnosis in hospitalization and emergency departments is necessary, and improving the ability to diagnose TB in physicians of other specialties—especially in emergency departments and during hospitalization—is also important. Good quality of diagnosis and clinical pathways, especially in emergency departments and during hospitalization, would decrease delayed diagnosis and improve TB infection control in hospitals. Some papers have also reported that the emergency department is a high risk area for TB transmission and delayed diagnosis is abundant.^{21,22} A high index of suspicion, prompt isolation, and diagnosis of potentially infectious hospitalized patients are needed to prevent TB transmission, especially in elderly patients.²³⁻²⁵

The data from our study are preliminary results. Further investigation of other hospitals is necessary in order to figure out the whole picture and to provide useful indices for monitoring TB infection control in hospitals.

To conclude, our findings indicate that the clinical processes of TB diagnosis and treatment are very complicated in hospitals, and delayed diagnosis is

most likely to occur in hospitalized patients followed by those in emergency departments. Delayed diagnosis in hospitalized patients also contributes to more severe TB exposure time than others. The quality of TB diagnosis in hospitalization and emergency departments should be enhanced, and improving the ability to diagnose TB in physicians of other specialties—especially in emergency departments and during hospitalization—is essential.

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