



The Investigation of a TB Cluster in a School, 2007

Mei-Ying Liu¹, Hsiu Shih¹, Pin-Hui Lee¹, Ta-Jen Chien¹
Shih-Yan Yang¹, Ru-Wen Jou², Hsu-Tah Kuo³

1. Second Branch, Centers for Disease Control, Taiwan
 2. Research and Diagnostic Center, Centers for Disease Control, Taiwan
 3. Mackay Memorial Hospital, Hsinchu
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Abstract

Early in November 2007, a hospital worker who contacted a TB patient had felt ill. Immediately, National Communicable Disease Notification System released this message. After initial study and research with our database, we found this index case was a graduate from “A” school in June 2007. Among 45 graduates in that class, a total of 6 students were notified as tuberculosis cases between July and November, 2007. A further expanded outbreak investigation was conducted which including confirmation of the name list of all the teachers, students and parents of the class and collection of all related information. After the cross examination of *Mycobacterium tuberculosis* strains for sputum

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- Correspondence : Liu Mei-Ying
- Address : No.15, Hangjhan S. Rd., Dayuan Township, Taoyuan County 337, Taiwan, R.O.C.
- e-mail: may@cdc.gov.tw

cultures positive, we found two waves of outbreaks that occurred in the class during December 2005 to November 2007, in which 10 students and 2 parents were notified. The genotype analysis of *Mycobacterium tuberculosis* strains indicated that the genotypes of 2 cases at the first outbreak in 2005 and 4 cases at the second wave of outbreak in 2007 were the same. Therefore, it was identified as a campus outbreak. The risk of morbidity for those students is 1,000 times higher than the same age students. A total of 9 counties and cities of public health and medical institutions cooperated and took six months to complete all students' data tracking. Other than one student who was notified as a tuberculosis case because of abnormal chest X-ray findings in July 2008, no other cases had been reported. On May 31, 2007, the definition of TB outbreaks was extended from cases occurring within one month to one year. This should be more effective in identifying outbreak. This outbreak had now been followed sufficiently and would need to continue the usual follow up from now.

Keywords: tuberculosis, contact investigation, clusters

Foreword

Tuberculosis is one of the most serious communicable diseases in Taiwan. According to the statistics of Taiwan CDC, 14,480 people were notified and confirmed to have tuberculosis (male 9,980 cases and female 4,500 cases). The incidence rate was 63.18 per 100,000 people (male 86.03, female 39.76). There were 2.16 times more male tuberculosis patients than female. Furthermore, the incidence rate of tuberculosis rises with age. Among all new patients, 51.6% were over 65 years old, 2.22%



were 15-19 years old. Among young people, around the age between 15 to 19, the incidence rate of female was 18.88 per 100,000 people [1].

According to our 2008 annual TB prevention report, after we compared with neighboring countries, we found the incidence rate and prevalence of 2006 in Taiwan (87/113 per 100,000 people) were higher than in Japan (22/29 per 100,000 people) and in Singapore (26/25 per 100,000 people) but the data was close to South Korea (88/123 per 100,000 people) and lower than the other Southeastern countries such as Vietnam (173/225 per 100,000 people) and Thailand (142/197 per 100,000 people). Comparison for young, for instance, the age and sex distribution for sputum smear positive showed that among 15-24 years old, the male and female reporting rate was around 10 per 100,000 people in Taiwan, less than 10 per 100,000 people in Singapore and less than 20 per 100,000 people in South Korea. Young people were belonging to the low incidence rate group in these countries [2].

In many countries, the first priority for TB prevention is the treatment for active TB patients. The secondary priority is to actively follow up and discover the active TB patient who are not yet been diagnosed and to find out the potential infected persons through contacts. In the United States, for example, approximately 10 contacts will be investigated for every confirmed TB case. About 20-30% of them are latent tuberculosis infection cases (hereinafter referred to LTBI); 1% of them are active TB cases. One half of those contacts felt ill at the first year after exposed. The prevalence is 100 times higher than regular population [3]. Hence, the local health units and populous institutions are willing to input more resources to examine the contacted people, raise awareness for high risk

group, implement health checkup and to properly educate public. These efforts will benefit to the tuberculosis case management. A 14-year-old junior high girl died of tuberculosis infection in September 2007 [4]. This incident caught a lot of attention and raised more awareness on the contacts screening among disadvantaged groups. It also highlighted the problem of our medical system that it may not be able to meet the needs of public health.

The TB cluster infection incidents are common in the nursing homes for elderly or physically and mentally disabled, very few of them have occurred in the hospital, or long-term care institutions. About 10% cluster incidents have occurred in jails and schools but the number of cases and the scale are relatively smaller. Because the *Mycobacterium tuberculosis* (hereinafter referred to MTB) is not easy to cultivate and is also limited by the resource of molecular genotyping, it's difficult to have a clear result to judge the past cluster incidents [5]. There were 11 notified cases in this cluster incident and 6 persons matched after genetic validation. This indicated that the early intervention of public health, efficient and thorough report through medical institutions and following up work of the National Communicable Disease and bacterial genetic database are very important.

Background

“A” school recruits students from three different school systems. During 2002-2007 school year, there were more than 6,000 students recruited every year. The places for students to study, accommodate, practice, dine and their daily activities are in different floor or in different



building. During their session, they study together but classrooms may be in different location. . The electrical fans are used in the classrooms and dormitory for ventilation. There is no central air conditioner. The dormitory is distributed by the class seating and it will be adjusted once every school year.

Informed by an email that there were some TB contacts who felt ill in November 2007. After contrasted with the system database, a total of 6 students of “A” school were classified as TB cases within 5 months after their graduation. These cases could not be detected in time because they belonged to different management units after graduation. Among them, 3 cases’ specimen were collected and found that they had same strain genotype after genotyping validation. Consequently, this incident was identified as a campus cluster. In order to clarify the scale of the incident, to find the infectious sources and to take appropriate prevention strategies, a comprehensive investigation is needed.

The Epidemic Scale

Case 10 was a health worker and also was notified as a contact. Refer to the National Surveillance Network of Communicable Diseases of Taiwan CDC, Case 10 was the contact of the student (case 5) who was notified from South district of Tainan City in July 2007, as well as the graduate of A school in 2007. In the meantime, among several contacts of case 5, some other classmates were also been notified. Thereafter, preliminary data validation was implemented.

After searched with the database, we found that case 5 was notified in July 2007, and then a physical examination for all contacts in total of 32

persons that included the same class classmates and tutor were completed. In addition to case 5 (the indicator at that time), a total of 6 persons included case 3, case 7, case 8, case 9 and case 10 were notified during July to November, but they respectively belonged to different management units such as Tainan City, Taitung, Taoyuan and Taipei County. As for the results of the sputum culture, 3 MTB, 1 nontuberculous mycobacterium (hereinafter referred to NTM) and 2 negative. Until February 2008, the *Mycobacterium tuberculosis* strains for case 5, case 8 and case 10 have been collected and sent to the Laboratory of *Mycobacterium* of Taiwan CDC for further genotype validation. The report was received in late April of 2008 and it confirmed that 3 strains had the same genotype. According to the definition of tuberculosis cluster infection of Taiwan CDC, and also corroborated with the evidence of bacteriology, this event could be classified as a cluster incident. Table 1 shows the onset time of incidence cases.



Table 1. The basic information for the tuberculosis cases of A school

case	sex	age	ID	Found reason	Reporting date	Management unit	Result of X-ray	Smear	Culture	Same genotyping	Follow up	contacts
1	F	20	Aboriginal	Health checkup	941202	Changhua County	Abnormal, with cavities	+	+	*	94/12/1 start treatment 95/6/8 complete treatment	2 Relatives 3 roommates
2	F	19	Aboriginal	Health checkup	950124	Taoyuan County	Abnormal, with cavities	-	+	*	95/1/23 start treatment 95/7/24 complete treatment	2 roommates
3	F	19	Non-Aboriginal	1)health check up 2)contact examine	950327 960926 (re-opened)	Taipei County	Abnormal, without cavity	-	-		1)95/6/19 Ruled out diagnosis 2)96/8/24 start treatment 97/3/31 complete treatment	3 relatives
4	F	19	Aboriginal	Medical treatment due to illness	960718	Hualien County	Abnormal, without cavity	-	-		96/7/18 start treatment 97/2/18 complete treatment	2 relatives
5	F	19	Non-Aboriginal	Medical treatment due to illness	960730	Tainan City	Abnormal, without cavity	+	+	*	95/8/1 start treatment 97/3/17 complete treatment	32 classmates (increased to 45)
6	F	19	Aboriginal	Contact examine	960815	Taipei County	Abnormal, without cavity	-	+	*	96/8/16 start treatment In treatment	none
7	F	19	Aboriginal	Contact examine	960828 970820 (re-opened)	Taitung County	Abnormal, without cavity	-	-		96/11/30 Ruled out diagnosis 97/8/20 start treatment	1 relatives Other 2 persons
8	F	19	Aboriginal	Contact examine	961012	Taoyuan County	Abnormal, without cavity	-	+	*	96/10/11 start treatment 97/4/14 complete treatment	1 relative 2 school contacts
9	F	19	Non-Aboriginal	Contact examine	961015	Taipei County	Abnormal, without cavity	-	+(NT M)		96/10/15 start treatment 97/4/23 complete treatment	31 career contacts
10	F	20	Non-Aboriginal	Medical treatment due to illness	961107	Taoyuan County	Abnormal, with cavities	+	+	*	96/11/6 start treatment 97/5/14 complete treatment	2 relatives 3 school contacts 27 career contacts
11	F	21	Non-Aboriginal	Medical treatment due to illness	970715	Taipei County	Abnormal, without cavity	+	-		97/7/14 start treatment	2 relatives 16 school contacts · 1 other person

These students were enrolled to the school in September 2002 and there were totally 53 students in that class. Some students were transferred or suspended during the sessions, and finally a total of 45 students graduated. Among them, 14 were Aboriginal. (One student was suspended for a year because of illness in 2005 and returned to school in January 2007 but was incorporated into other class). After checking the basic information of the class and found that a total of 8 cases were notified as TB cases in this cluster incident (during July to November 2007), in which 2 students' onset time was similar to case 5, but they did not declared to the doctors that they were the graduates of "A" school until the entire class list was confirmed.

Another three students (case 1, case 2 and case 3) have been notified as TB cases during December 2005 to March 2006. Among them, case 3 was excluded the diagnosis of TB but was notified again in 2007 and then received the completed treatment. A total of 10 TB cases were notified during December 2005 to November 2007. With the assistance of the medical hospitals, the *Mycobacterium tuberculosis* strains of case 1 and case 2 were sent to the *Mycobacterium tuberculosis* laboratory of Taiwan CDC to reserve; the sputum sample of case 6 was examined by the TB contract laboratory of Taiwan CDC so that those samples could be sent to the laboratory for further genotype validation. The genotype results of these three cases and the aforementioned three cases were the same. It indicated that the students felt ill one by one after they graduated in 2007 should be the continuation of the first wave epidemic in December 2005.



Contact Investigation

Among 10 TB notified cases, the parents of case 2 and case 8 were separately managed by the County Health Bureau of Chiayi and Changhua. However, case 2 and case 8 were not listed as close contacts and had been investigated at that time. The sputum culture of case 2's father was negative at the beginning; the genotype was different from the index case after the laboratory test. Yet the genotype of case 8 was the same as the other five classmates, therefore, the possibility of the household infection for case 8 was excluded.

Chest X-ray is used to examine the contacts in Taiwan. Regarding the investigation for 10 contacts of notified cases, some family contacts (like case 3, case 4) and school contacts (like case 2, case 5) were investigated, but the contact of case 6 has never been investigated. Moreover, for case 10, career contacts, family contacts and school contacts have been investigated. It showed that to perceive and to implement the operational definition of the contacts were different in every management unit.

Investigating the Source of Infection

The students in different school systems are in different floor, buildings where they study, accommodate, practice, having meal and their daily activities. During the school session, there is no central air conditioning; the electrical fans are used in the classrooms for ventilation. The whole class study together as a group but in different class location. It's common for the peers among adolescent girls who like to hang out together. The junior college students are compulsory dormitory resident. The dormitory is distributed by the class seating and will be adjusted once

every school year. The room in dormitory is usually having four-bed in one room; with up and down sleeping beds, no air conditioner and electrical fans are used for ventilation. The student are divided into different groups for intern practice so they usually spent a lot of time with each other. Since they live and do their intern together, the total hours they are together is exceeding 8 hours per day. Case 1, case 2 and case 3 were notified as TB cases during December 2005 to March 2006, because the chest x-ray examination for those students have been completed in November 2005 (the routine physical examination for fourth grade students), all infected students were treated. However, the chest X-ray results for the other students' were normal, their health condition have not been followed up by school and the public health system, so they probably became the infectious source of the first wave of outbreak in 2005.

Among all the students in these 22 classes in the same school year, there were respectively 1 and other student except 1 student in three other classes (except the indicator class I, the other three were presented as II III and IV) notified as TB cases, of which 2 students were MTB after the first time sputum test during December 2005 to January 2006(after the routine physical examine for the fourth grade). TB ramet Laboratory of Taiwan CDC was asked to check the reserved strains and compared with the genotype of aforementioned students' strains. The result was two different genotypes were confirmed. Accordingly, the other classes were excluded in this cluster incident. The figure 1 shows the result of the genotype. After checking the database, there were three other students were notified as TB cases before they were enrolled (in February and July of 2002) the results of sputum culture were negative, possible and no result respectively.



However, after a long lapse of time, no more reserved strains could be clarified as the possible relevance. The other two students had been notified as TB cases in 1997 and 1999 and received the complete treatment. After checking the database, six school staff had been notified as TB cases (before 2004); five of them had received complete treatment except one staff because we did not have sufficient data to confirm it.

Case Rate

There were 46 students in the graduating class (included one student who was suspended after been notified and then delayed to graduate), the incidence rate of aboriginal students (42.9%, 6/14) was 3.5 times of non-aboriginal students (12.5%, 4/32). The students' incidence rate in the index class was 21.74% (10/46), which was approximately 1,000 times higher than the year of 15-19 female (18.88 per 100,000 people) in Taiwan, 2007. In addition, school teachers were not notified. There were about 7,000 teachers and students in the school and only 2 cases were notified. The incidence rate was 0.0285%, which was still higher than in Taiwan. At this point, due to insufficient information, we can not explain the actual cause.

Prevention Strategy

When the first wave of outbreak occurred in 2005, it coincided with the time that the physical examination for the fourth grade students has been completed. In addition to two confirmed cases that needed to be treated, one roommate (case 9) had been included in the close contacts list but no prevention strategy had been taken at that time. After the case 5 was

notified in July 2007, the follow-up treatment for the contacts had been implemented with the help of the local health bureau. The health bureau sent a paper to the school for seeking assistance and mailed the referral sheets to the contacts. The school also requested the same class students to have chest x-ray done at the local hospital. A total of 32 persons (included one tutor) had completed the physical examination in September 2007. However, after those students have graduated from school and returned to their hometown, 14 students were still uncompleted the chest x-ray check and no result had been provided so that they were not included in the contact lists timely. Until the result of the genotype had been revealed in May 2008, the school was interviewed again and the related information had been collected such as the data of dormitory, practice and the families etc. Moreover, the medical records and the physical examination data of students were also accessed. In the mean time, the commander of the Infectious diseases medical network, the member of the TB Advisory Committee and the senior executives of "A" school were invited to discuss how to deal with the following related issues.

Some important resolutions have been made in the meeting as following : (1) the chest x-ray check for the other students in the same class should be accomplished. (2) to check if there is any notified case in the same grade. (3) to strengthen the chest x-ray check for school staff and students in the next 3 years. The results of the chest x-ray of the fourth grade students and the data of ten notified cases are needed to be double checked in late May 2008. Case 7, the notified one who was originally excluded, was suggested by the committee members to have a chest x-ray, sputum recheck and also to be treated. Meanwhile, the physical

examination for the whole class students should be completed. In addition, some recommendations have been made to improve quality of the clothing and the films of -ray when the chest x-ray is preceded.

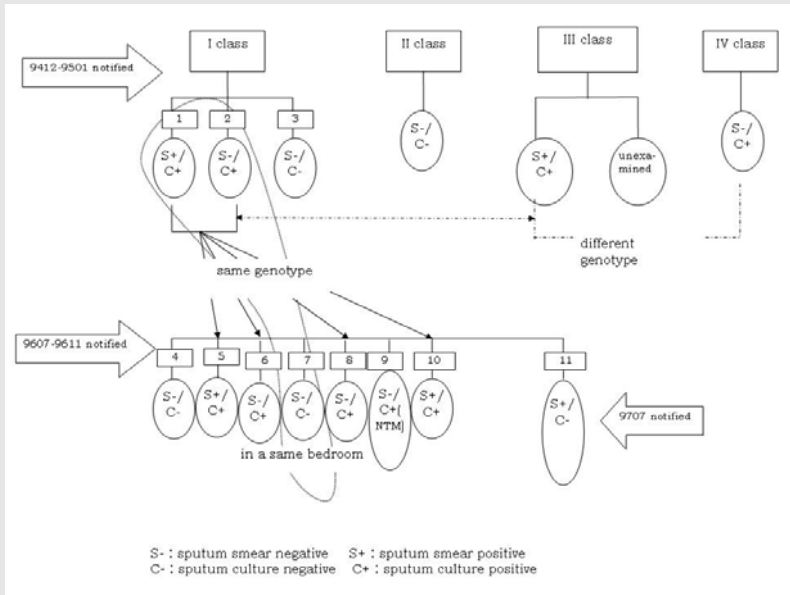


Figure 1. The result of genotype validation for “A” school students

Discussion

According the statistics of annual report of Taiwan CDC, the TB incidence rate in different regions in Taiwan has a significant difference. The TB incidence rate in the aboriginal villages (206.11 persons, per 100,000 people) is approximately 3.26 times higher than the other regions in Taiwan [1]. The TB incidence rate of aboriginal students in the graduated class is 42.9% (6/14), which is 3.5 times higher than the

non-aboriginal students (the incidence rate is 12.5% (4/32)). The routine physical examination in “A” school is arranged for the first and the fourth grade students. The time between first and fourth year were done by private medical institutions. As for the students both with special identity and health caregiver are not asked to increase the frequency of the physical examination.

The source of this outbreak was started when there were 4 students notified as TB cases in the class within 2 months after graduation, and 8 notified cases were investigated within 4.5 months. After contrasted and found that the genotype was the same with 2 notified cases in December 2005. In spite of the initial source of infection was not found, but the evidence was sufficient to show that those students had the possibility of common exposure or infection. The potential risk have existed for the members who are working for their intern. In particular, the third-grade students in “A” school will be arranged to the hospital for internship. To avoid the above potential risk, the physical examination for interns should be completed before internship.

In the United States, in average, 10 contacts will be checked for every TB confirmed case [3]. However, in Taiwan, according to the statistics of Taiwan CDC in 2006, there are averagely 2.6 contacts had been checked for every TB confirmed case. In this incident, 2 parents were notified as TB confirmed cases but their 2 children were not included in the list of close contacts because they were resident students. As for the contact investigation for 10 notified students, due to the different management units, the comprehension of the investigation in different health bureau were obviously different. Moreover, by the time the second wave of



outbreak was notified in July 2007, the students had already graduated from school. A total of 32 persons' physical information were collected through the contacts check-up referral sheets, but 14 students did not have physical check-ups until this event was confirmed as a cluster incident. Therefore, there are still possible risks for the potential infection and transmission. The contact management as well as the authorities and responsibilities of epidemic investigation are needed to be well regulated.

When the first wave of outbreak occurred in 2005, the local health institution and school had applied the "Principles for the Suspected TB Cluster Infection" according to the "TB Prevention Work Manual" to regulate the suspected TB outbreak. For the definition of "time": case report must be reported within 30 days interval; over 31 days (include 30 days), the notified case will be dealt with individually by the Contact Case Procedure for Regular Case Management [6] and the special suspected cluster investigation will not be taken. Fortunately this event was confirmed as a cluster incident because this paper was sent by Taiwan CDC to all Health Bureaus on May 31, 2007 that was within a year (365 days) and according to amended the definition of the notification time interval for TB cluster infection. The timing notification had attracted a lot attention and therefore the further investigation has been carried out.

Both the parents were notified in this incident and the first wave outbreak occurred before the definition of suspected TB cluster infection was amended. Consequently, the original close contacts, included few students who lived in the same bedroom were listed as tracking contacts. When the parents fell ill, their resident children were not listed as management objects. Therefore, both the school and the health institutions

have no such information so that it was difficult to implement the registration management for the possible exposure persons and environment before infected persons were diagnosed. The definition of the close contact was amended in June 2007, in which it emphasized that to strengthen the physical checks for the non-living together close contacts will help to reveal such cluster incidents. To properly educate the campus contacts when conducting the health checks and let them understand that they have the history of exposure to tuberculosis, so they will go to medical treatment as soon as possible when the suspected symptoms appear and the suspected cases could be find earlier.

Nowadays the frequency and the items of health check for students are conducted according to the Student Health Inspection Benchmark Table of School Health Act. It is particularly regulated for the special student groups. As for the special identity students such as the medical-related department students, the chest x-ray should be done before internship along with the regulation of new staff before their practice in medical institution, the suspected cases could be find earlier and the risk of the internal cycle infection could be decreased. In addition, improving the quality of chest x-ray in the medical institutions, building up the surveillance system for infected students, school as well as hospital and notifying the infection information timely are very important to prevent the cluster infection in the future.

Moreover, by looking back the information of 7 notified cases (separately belonged to four classes) of “A” school from 2005 to 2006, because of the limited information, the source of the notified cases in 2005 could not easily be found. However, the scale of the epidemic could be



reduced by reinforcing the monitoring for the contacts and implement the LTBI treatment.

In this incident, with the help from the related medical institutions that took the initiative to retain or provide TB strains so that the relevance for the onset students and parents in different period were verified after the laboratory validation. It sufficiently shows that the value for the establishment of National *Mycobacterium tuberculosis* gene database.

Conclusion

To input efforts on contact investigation is vitally important to the outcomes of TB prevention. The nurses in local health institutions need to be responsible for the tracking management of the contacts in household and special institutions. According to the statistics, more than ten persons will be infected by an undetected and untreated active TB case within one year. With a little bit negligence, all the efforts on TB prevention in local areas will be in vain. Therefore, when local health authorities are conducting the workload distribution, they must understand that their higher priority are contacts investigation and health education.

In 2007, a total of 14,437 persons were notified as TB confirmed cases in Taiwan. With such a high incidence rate, there is still a great room for the goal of a plan to halve the number of tuberculosis patients within ten years, which the notified cases may be reduced to 7,500 persons per year. The central government should cooperate with local public health systems and medical institutions, and work together on the contact investigation to detect and treat TB cases. In order to reach the highest target of the plan to halve the number of tuberculosis patients in ten years,

to reduce the possible sources of infection and to treat the potential TB-infected people are necessary.

After Taiwan CDC implements the DOTS project to cure the active TB patients, the LTBI treatment for younger ages is starting promoted in April 2008. The highest TB incidence rate is located in the aboriginal villages in Taiwan (there are 30 aboriginal villages in Taiwan, only 4 villages' incidence rate are lower than 63.18 persons, per100, 000 people, many townships are up to 100-300 persons) [1]. In this incident, 6 cases are aboriginals or coming from aboriginal villages and two waves of outbreaks had occurred in sequence. To prevent this problem, implementing the policy of the LTBI treatment for aboriginal villages or other special groups is necessary.

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