

**Original Article**

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**A cross-sectional study of sputum handling by and supervision of patients with pulmonary tuberculosis treated at home in China****Lin Mei<sup>1</sup>, Ruoyan Gai Tobe<sup>1</sup>, Hong Geng<sup>2</sup>, Yunbo Ma<sup>3</sup>, Ruiying Li<sup>4</sup>, Weibing Wang<sup>5</sup>, Lesego Selotlegeng<sup>1</sup>, Xingzhou Wang<sup>1</sup>, Lingzhong Xu<sup>1,\*</sup>**<sup>1</sup> Institute of Social Medicine and Health Services Management, Shandong University, Ji'nan, Shandong, China;<sup>2</sup> Tuberculosis Control Center of Shandong Province, Ji'nan, Shandong, China;<sup>3</sup> Linyi People's Hospital, Linyi, Shandong, China;<sup>4</sup> Weihai Center for Diseases Control and Prevention, Weihai, Shandong, China;<sup>5</sup> Institute for Tuberculosis Control of Changqing District, Ji'nan, Shandong, China.**Summary**

Disposal of sputum from patients with pulmonary tuberculosis (TB) who are treated at home is an important aspect of preventing the spread of TB. However, few studies have examined disposal of sputum by patients with TB who are treated at home. Patients with pulmonary TB who are treated at home were surveyed regarding sputum handling and supervision. A cross-sectional survey of a representative sample of patients with pulmonary TB who are treated at home was conducted in Shandong Province. Participants were individuals with TB who had been registered with a local agency responsible for TB control. Participants completed a questionnaire with both qualitative and quantitative questions. How sputum was handled was determined and factors associated with sputum disposal were analyzed using a non-parametric test, logistic regression, and content analysis. Responses were received from 720 participants. Patients expectorated sputum  $4.56 \pm 10.367$  times a day, and 68.6% of patients responded that they correctly disposed of their sputum. Supervision as part of TB control focused on the efforts of health agencies and paid little attention to waste management by patients. A non-parametric test showed that sputum disposal was significantly associated with gender, age, education, sputum smear results, attitudes toward waste management, and attitudes toward supervision (all  $p < 0.05$ ). Logistic regression analysis showed that gender ( $OR = 0.482$ , 95% CI: 0.329-0.704), sputum smear results ( $OR = 1.300$ , 95% CI: 1.037-1.629), and level of education ( $OR = 0.685$ , 95% CI: 0.528-0.889) were associated with receipt of TB health education (all  $p < 0.05$ ). Sputum handling by and supervision of patients with pulmonary TB who are treated at home is severely wanting. From a policy perspective, special attention should be given to the definition, details, and methods of supervision of waste management by patients with TB to give them relevant health education and enhance their willingness to be supervised. A financial incentive should be provided to health workers supervising management of TB-related waste.

**Keywords:** Waste management, sputum, tuberculosis, supervision, cross-sectional survey**1. Introduction**

Tuberculosis (TB) is an infectious disease caused by the bacillus *Mycobacterium tuberculosis*. It

typically affects the lungs (pulmonary TB) but can affect other sites as well (extrapulmonary TB). TB can be transmitted in several ways, including *via* the respiratory tract and *via* the gastrointestinal tract. Several unusual methods of transmission have recently been reported, *e.g.* infections as a result of the use of contaminated equipment that was poorly cleaned (1-3). However, TB infection usually occurs in the lungs, with infection *via* the respiratory tract accounting for 95.93% of TB transmission (4). The main route of TB

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infection is *via* the respiratory tract, which includes droplet infection and airborne infection. Given this fact, incorrect waste management by patients with TB can result in aerosolized bacteria that will infect others who come into contact with the bacteria. Poor management of TB-related waste has been reported as a risk factor for increasing susceptibility to active TB infection (5-8). Therefore, studies have begun to focus on ways to appropriately manage waste from health care facilities as part of TB control (9,10). Because of the key role patients play in managing TB-related waste, supervision of waste management by patients with TB is also an important component of TB control. Therefore, waste management by patients with TB has been supervised in China since 1992 (11).

TB is a chronic disease with a long course of treatment. Because of social, financial, and family factors, most patients are treated at home (12,13). Thus, there is a need to examine waste management by patients with TB who are treated at home (PTBTHs). According to the existing data, TB control policies in China encompass supervision. However, current waste treatment by and supervision of PTBTHs has seldom been studied. This study defined waste management by patients with TB as how patients disposed of sputum, sputum cups, everyday items (clothes, bedding, tableware, and rags), and medical waste (respirators, handkerchieves, tissue paper, pharmaceutical packaging, infusion apparatuses, and syringes). Therefore, supervision of waste management should focus on the items listed. This study sought to explore current sputum disposal and supervision of that disposal, both of which are crucial to waste management by PTBTHs.

## 2. Materials and Methods

### 2.1. Materials

Multi-stage random sampling was used to select Weihai, Ji'nan, and Linyi as survey sites based on their level of economic development and geographical location (eastern, central, western regions) in Shandong Province. In each city, 2 counties were selected, and in each county 6 towns were selected at random. This study was conducted from August to September 2012. The three districts represent three levels of economic development in Shandong Province (Linyi: slow, Ji'nan: moderate, and Weihai: rapid).

In 2011, Linyi had a per capita GDP of 20,869 RMB (approximately 3,161 US dollars) and a population of 10,150,411, Ji'nan had a per capita GDP of 58,533 RMB (approximately 8,869 US dollars) and a population of 5,900,768, and Weihai had a per capita GDP of 69,858 RMB (approximately 10,585 US dollars) and a population of 2,483,889 (13). The current survey focused on PTBTHs and 720 PTBTHs were interviewed. The Ethics Committee of Shandong University approved this

study. The study was conducted after obtaining informed consent from all participants.

### 2.2. Methods

In-depth interviews were conducted with patients to ascertain how they disposed of their sputum. A semi-structured questionnaire was designed by the Institute of Social Medicine and Health Services Management, School of Public Health, Shandong University, China. It included general status, economic indicators, TB status, changes in living habits, awareness of and attitudes towards waste management, social activities, and cell phone and Internet use.

Quantitative data were analyzed with SPSS version 13.0 statistical software. Descriptive analysis and a non-parametric test were performed on quantitative data.

Content analysis was used to analyze qualitative data. All aspects influencing sputum handling at home that patients brought up in interviews were listed, and then a card was made for each aspect mentioned. Similar aspects were grouped together, and then the groups were arranged into a relationship model in a logical order.

The Ethical Research Committee of Shandong University approved this study and informed consent was obtained from each patient. All participants were informed about the study procedures and the survey was conducted after informed consent was obtained.

## 3. Results

### 3.1. General information on TB control in China

TB is the leading cause of death from a curable infectious disease. TB Impact Measurement revealed an estimated 8.7 million incident cases of TB (range, 8.3 million-9.0 million) globally, equivalent to 125 cases per 100,000 population in 2011 (4). The five countries with the largest number of incident cases in 2011 were India (2.0 million-2.5 million), China (0.9 million-1.1 million), South Africa (0.4 million-0.6 million), Indonesia (0.4 million-0.5 million), and Pakistan (0.3 million-0.5 million). China alone accounted for 12% of global cases. There were an estimated 899,669 new cases of TB in China, 56% of which had positive sputum smears (the most infectious cases).

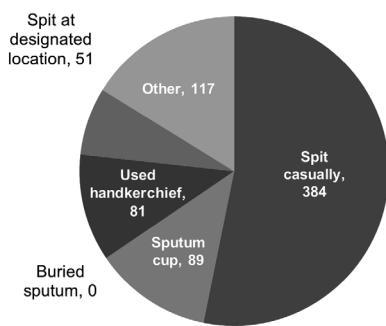
Since the Directly Observed Treatment Short Course strategy (DOTS) was implemented in China in 1992, China has made great progress in TB prevention and treatment over the last few decades. In 2006, the DOTS coverage rate was 100% at the county level, the detection rate for new smear-positive TB cases was 79%, and the cure rate was 92% (11). During implementation of the DOTS program, supervision plays a very important role in informing community members of TB symptoms and transmission to help

prevent its spread. Supervision has been shown to improve sputum disposal by providing patients with the information necessary to understand the importance of sputum disposal (14-18).

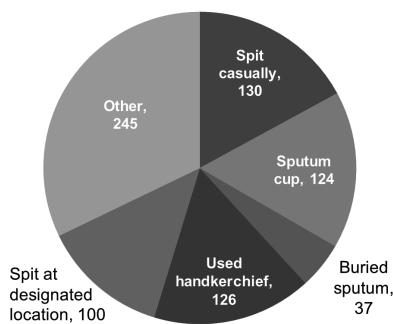
However, the supervision of patients with TB is still inadequate. Supervision as part of TB control in China emphasizes efforts by health agencies, such as specimen collection, analysis of TB information, and monitoring of TB epidemics. Health education is focused more on identifying TB cases and ensuring that medication is taken in the right combination and appropriate dosage while observing patients taking TB medications (19,20). Therefore, waste management by patients with TB has received insufficient attention in China.

### 3.2. General information on PTBTHs

Among the sample of 720 patients with TB in Shandong Province, those treated within a month expectorated sputum  $4.56 \pm 10.367$  times a day. Asked how they disposed of their sputum before diagnosis, 384 patients spit casually, 89 patients used a sputum cup, none of the patients buried their sputum, 81 patients used a handkerchief to collect their sputum, 51 patients spit in a designated location, and 117 patients said they used other methods to dispose of their sputum or that they had no sputum (Figure 1). Asked about how they disposed of their sputum in the first month of



**Figure 1. Handling of sputum before diagnosis.**



**Figure 2. Handling of sputum during the first month of treatment.**

treatment, 130 patients spit casually, 124 patients used a sputum cup, 37 patients chose to bury their sputum, 126 patients used a handkerchief to collect their sputum, 100 patients spit in a designated location, and 245 patients said they used other methods to dispose of their sputum or that they had no sputum (Figure 2). These findings indicate that the number of patients who chose to spit casually decreased significantly and the number of patients who appropriately disposed of their sputum increased.

Differences in the characteristics of patients with TB who correctly disposed of sputum (DS+ patients) and those who incorrectly disposed of sputum (DS- patients) are shown in Table 1. Differences among age groups were noted ( $p < 0.05$ ): 80.5% of patients 10-25 years of age were DS+ patients, 80.0% of those 26-40 years of age were DS+ patients, 72.5% of those 41-55 years of age were DS+ patients, 60.9% of those 56-70 years of age were DS+ patients, and 67.0% of those  $\geq 70$  years of age were DS+ patients.

The ratio of male to female patients was 2.36:1 (506/214). Gender differences were noted since 64.2% of men and 79.0% of women disposed of sputum correctly. By level of education, 64.5% of patients with no more than a primary school education disposed of sputum correctly, 70.9% with a high school education did so, and 82.9% with a technical secondary school or higher education did so. The difference in correct disposal of sputum by patients with different levels of education was statistically significant ( $p < 0.05$ ). With regard to treatment outcomes, 50.3% of patients had been cured and 47.4% were undergoing treatment. Of 362 cured patients, 68.8% responded that they disposed of sputum correctly and 68.3% of the patients undergoing treatment did so. With regard to sputum smear results, 16.1% of the patients were had positive smears, 33.6% had negative smears, and 50.3% had smear results that were not known. Of 116 smear-positive patients, 74.1% responded that they disposed of sputum correctly as did 74.0% of smear-negative patients and 63.3% of patients with smear results that were not known. A statistically significant difference was noted in terms of sputum smear results ( $p < 0.05$ ).

Economics played a role since 44.6% of patients had a salary of 0-9,999 RMB while 55.4% had a salary of  $\geq 10,000$  RMB group. However, the proportion of patients who correctly disposed of sputum did not differ statistically between income levels ( $p = 0.135$ ).

Of the patients, 59.9% responded that they cared about waste management, 34.3% thought it unnecessary, 5.8% had no feelings either way. The difference in sputum disposal in terms of attitudes toward waste management was statistically significant ( $p < 0.05$ ): 72.2% of the patients who considered waste management necessary correctly disposed of sputum, 63.6% of the patients who considered it unnecessary did so, and 61.9% of the patients with no feelings

**Table 1. Differences in characteristics of patients with TB who dispose of their sputum correctly (DS+) and incorrectly (DS-)**

Item	Dispose of sputum correctly		Dispose of sputum incorrectly		Statistics	p
	n	(%)	n	(%)		
Gender						
Male	325	64.2	181	35.8	15.178	< 0.001
Female	169	79.0	45	21.0		
Age (years)					19.523	0.001
10-25	66	80.5	16	19.5		
26-40	64	80.0	16	20.0		
41-55	108	72.5	41	27.5		
56-70	179	60.9	115	39.1		
70+	77	67.0	38	33.0		
Education					10.238	0.006
Primary school or less	251	64.5	138	35.5		
High school	185	70.9	76	29.1		
Technical secondary school or higher	58	82.9	12	17.1		
Yearly salary (RMB)					2.229	0.135
0-9,999	211	65.7	110	34.3		
10,000+	283	70.9	116	29.1		
Treatment outcome					0.049	0.976
Cured	249	68.8	113	31.2		
Treatment underway	233	68.3	108	31.7		
Other	12	70.6	5	29.4		
Sputum smear results					9.682	0.008
Positive	86	74.1	30	25.9		
Negative	179	74.0	63	26.0		
Not known	229	63.3	133	36.7		
Attitudes toward waste management					6.317	0.042
Necessary	311	72.2	120	27.8		
Unnecessary	157	63.6	90	36.4		
No feeling either way	26	61.9	16	38.1		
Attitudes toward supervision					11.130	0.004
Necessary	325	72.9	121	27.1		
Unnecessary	117	59.7	79	40.3		
No feeling either way	52	66.7	26	33.3		
Received health education					3.073	0.080
Yes	343	70.7	142	29.3		
No	151	64.3	84	35.7		
Supervised					2.781	0.095
Yes	164	72.9	61	27.1		
No	330	66.7	165	33.3		

either way did so. With regard to supervision, 62.0% responded that supervision was necessary, 27.2% thought it unnecessary, and 10.8% had no feelings either way. A statistically significant ( $p < 0.05$ ) difference was noted in terms of attitudes since 72.9% of patients who considered supervision necessary disposed of sputum correctly, 59.7% of patients who considered it unnecessary did so, and 66.7% of patients with no feelings either way did so.

Asked about receiving health education, 67.4% of patients received health education and 32.6% did not. Of 485 patients who received health education, 70.7% responded that they correctly disposed of sputum while 64.3% of patients who received no such education responded that they did so. Asked whether they were supervised, 31.3% of the patients were supervised while 68.7% were not. Of 225 patients who were supervised, 72.9% responded that they disposed of sputum correctly while 66.7% of those who were not supervised did so. However, the proportion of patients who correctly disposed of sputum did not statistically differ for those who received health education ( $p = 0.080$ ) or who were supervised ( $p = 0.095$ ).

Supervision details such as supervisors, approaches,

scope, and frequency were also ascertained. Among the sample of 720 PTBTHs, 225 patients (31.2%) confirmed that they had been supervised and 495 patients (68.8%) said they had not been supervised. Among the 225 patients who were supervised, 27.6% said that family members supervised waste management, 13.8% said that a rural doctor did so, and 17.8% said that a doctor at a township hospital did so. Of the 225 patients, 65.8% confirmed that staff of the county-level agency responsible for TB control supervised their management of TB-related waste. Asked about the approach to supervision, 6.2% of patients were supervised in writing, 30.7% were supervised face-to-face, and 18.2% were supervised by phone; 60.4% of patients were supervised during treatment. Regarding the scope of supervision, 78.2% of patients were instructed in sputum disposal, 43.1% were instructed in use of items such as a handkerchief or rag, 34.2% were instructed in use of a sputum cup, 25.3% were instructed in handling of medication packaging, 22.7% were instructed in handling of syringes and transfusion systems, 28.9% were instructed in handling of used clothing, bedding, and other everyday items, 33.3% were instructed in handling of used tableware, 32.4% were instructed in

**Table 2. Logistic regression analysis of influencing variables**

Risk factor	B	S.E.	OR	95% CI for OR Lower / Upper	p
Sputum smear results	0.262	0.115	1.300	1.037 / 1.629	0.023
Gender	-0.730	0.194	0.482	0.329 / 0.704	< 0.001
Level of education	-0.378	0.133	0.685	0.528 / 0.889	0.004

handling of used tissues, and 30.7% were instructed in handling used respirator. Supervision took place at a frequency of  $4.70 \pm 7.415$  times.

A logistic regression model was used to identify factors influencing sputum disposal by PTBTHs. Table 2 shows the influencing factors identified by logistic regression. A finding of significance in an omnibus test of model coefficients ( $p < 0.0001$ ) indicated that data were adequately fitted to the model.

Three factors were associated with sputum disposal by PTBTHs: sputum smear results, gender, and level of education. PTBTHs who were unaware of their sputum smear results were less likely to dispose of sputum correctly compared to those who were aware of their results ( $OR = 1.300$ , 95% CI: 1.037-1.629). Female patients were more likely to dispose of sputum correctly than were male patients ( $OR = 0.482$ , 95% CI: 0.329-0.704). PTBTHs who were more educated were more likely to dispose of sputum correctly ( $OR = 0.685$ , 95% CI: 0.528-0.889).

### 3.3. Results of qualitative research

In addition to quantitative data, this study provided qualitative information regarding patients' ideas of and views on sputum disposal, health education, and supervision.

The survey revealed that waste management by patients with TB is still lacking. As an example, a TB treatment room accommodating four patients had only one window and no ventilation. There were plastic sputum cups with a plastic bag inside that were supposedly disinfected. Staff were asked how they sterilized the sputum cup but they answered that they simply threw away the plastic bag with sputum inside. Staff were asked about the health education they provided and they said that health education was provided every time patients visited; they also mentioned other forms of health education such as bulletin boards and noncommercial ads. Asked about supervision, staff responded that supervision was inadequate compared to health education. Recent supervision has focused more on administrative aspects such as management of funds, detection, management of medication. Waste management by patients is still not adequately supervised.

Staff cited the importance of health education during sputum disposal. They felt that patients with adequate health education would better understand how

to correctly dispose of sputum and thus try to do so. Several such views were expressed:

'The expert said that correct disposal of sputum helps to control TB... spitting casually is not good for yourself or others, so I never spit casually. I always carry a plastic bag (to spit in) when I go out...'

'During my treatment, the doctor always told to me how I should dispose of sputum and what might happen if I spit casually... of course, I will do what's right for myself and others...'

Some patients mentioned staff attitudes towards supervision. They described being reminded by others to act appropriately whereas patients who received no such attention expressed less concern:

'The doctor talks to me every time he sees me on the street and asks me how I feel and how my treatment is going... the TB supervisor asks me if I am taking my medicine and what else I'm doing... I will do what they told me and get cured as soon as possible (because of this kind of care)...'

'Since nobody cares about how I feel or how I am, why should I care about my health behavior? After all, I'm the one who's sick.'

However, current supervision has drawbacks. Patients who were supervised were asked about their supervision. They said that supervision was flawed and not standardized or consistent:

'...the doctor asked about my treatment all the time... he always mentioned the medicine... he didn't seem to care much about how I disposed of my sputum...'

'Of course, no one does that job (supervision) regularly. Sometimes they said something about it (supervision), and sometimes they didn't.'

Some patients said that they do not want to be supervised or receive health education because they are afraid of being discriminated against by others who would realize that they had TB:

'I know this disease is contagious, but I don't want to be supervised or receive health education... other people will know that I have TB if I do, and I will be discriminated against...'

### 4. Discussion

This study found that 68.6% of the PTBTHs in Shandong Province responded that they correctly disposed of sputum. The rate of appropriate sputum disposal by PTBTHs in China is consistent with the high rate of DOTS coverage and other quality indicators

for TB treatment reported by the Ministry of Health of China.

This study noted statistically significant differences in sputum disposal by PTBTHs in terms of gender, age, level of education, sputum smear results, attitudes toward waste management, and supervision. This study identified three statistically significant influencing factors: sputum smear results, gender, and level of education.

Health education has improved but is still inadequate. Of the patients surveyed, 67.4% had received health education. However, many patients described a lack of concern during treatment and health education. The approach to health education was mostly face-to-face education during a visit. New approaches to health education must be explored.

This study found that the current supervision of PTBTHs is still inadequate despite the important role waste management by patients plays in TB control. Of patients, 61.9% were willing to be supervised and 31.3% were actually supervised. Although family members and agencies responsible for TB control help PTBTHs to manage their waste, rural doctors and doctors in township hospitals should enhance their supervision of waste management by PTBTHs. Methods of supervision are still limited. Being supervised face-to-face and being supervised during treatment were the predominant forms of supervision, and further attention should be directed toward more efficient and effective supervision *via* technology such as use of phone calls or the Internet. The scope of supervision also needs to be expanded. Used sputum cups, used tableware, everyday items, and used respirators can also spread TB (21,22). The handling of these items must be supervised to control TB. Medical staff and patients indicated that supervision is focused more on supervising administrative aspects and patient treatment. Specialized health workers in agencies responsible for TB control are expected to better supervise the population. That said, caution is required with regard to these specialists' supervision of waste management by PTBTHs. Health workers currently have no firm rules regarding how they should supervise waste management by patients with TB and what they should do when supervising those patients, so they do not know what to do or how to do it. For PTBTHs, failure to appreciate the importance of waste management and the fear of been discriminated against are major barriers to a willingness to be supervised. These aspects may have led to the current findings.

In order to improve sputum disposal by PTBTHs, the current study suggests that greater attention must be paid to the definition, details, and methods of supervision of waste management by patients with TB from a policy perspective. Supervision with specific aims is more effective, which may be explained by the fact that doctors who have received clear guidelines

are better able to supervise management of TB-related waste (23,24). Defining the supervision of waste management by patients with TB results in health workers who are better able to effectively and efficiently supervise the management of TB-related waste.

This study found that another factor, the willingness of PTBTHs to be supervised, has a large impact on the actual receipt of health education. Therefore, this study suggests that providing PTBTHs with relevant health education and encouraging a willingness to be supervised can help improve their sputum disposal. This might be explained by the fact that patients who have received health education are better able to manage TB-related waste on their own (25). More relevant health education must be developed so that PTBTHs are better able to manage TB-related waste on their own.

This study also suggests that health workers should be provided a financial incentive to supervise the management of TB-related waste. Awareness of national financial incentives has been indispensable to the supervision of the management of TB-related waste. Health workers should be financially rewarded for supervising management of TB-related waste. Health workers need to be directly rewarded for their supervision of the management of TB-related waste. A previous study examined the importance of personal needs with a focus on economic rewards (26).

In summary, most PTBTHs responded that they correctly disposed of their sputum. In addition, the factors of gender, level of education, and sputum smear results were found to be associated with sputum disposal by PTBTHs. These findings will help to plan future strategies to encourage correct sputum disposal by PTBTHs as part of TB control and prevention.

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