Effect of Short Message Service on Management of Pulmonary Tuberculosis Patients in Anhui Province, China: A Prospective, Randomized, Controlled Study

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Background:
To explore the significance of short message service (SMS) on the management of pulmonary tuberculosis (TB) patients in reinforcing the treatment adherence and health awareness, and provide scientific evidences for popularizing this model and formulating related polices and measures.

Material/Methods:
Six counties (districts) were selected by stratified cluster sampling method, and randomly divided into control group and intervention group. Pulmonary TB patients eligible to the study criteria were included in the study. SMS management and regular education of core knowledge about pulmonary TB were carried out in SMS group patients. The conventional directly observed therapy (DOT) was carried out in control group. Data was collected by questionnaire method.

Results:
A total of 350 patients were included in the study, including 160 cases in the SMS group and 190 cases in the control group. There were 270 males (77.1%) and 80 females (22.9%). The treatment completion rate in SMS group (96.25%) was significantly higher than that in the control group (86.84%) (χ^2=9.52, P=0.002). Both the interrupted treatment rate and the missed dose rate in the SMS group were significantly lower than those in the control group (χ^2=10.41, P=0.001; χ^2=28.54, P<0.001). After a period of treatment, the reexamination rate of SMS group patients was significantly higher than that in control group (except the reexamination rate after 5 months treatment).

Conclusions:
The management of pulmonary TB patients by SMS can effectively reinforce the completed treatment rate of pulmonary TB patients and reduce their missed dose rate and interrupted treatment rate, and further enhance their reexamination awareness. Therefore, SMS on the management of patients may be a new promising therapeutic strategy for pulmonary TB.

MeSH Keywords:
Directly Observed Therapy • Patient Compliance • Text Messaging • Tuberculosis, Pulmonary

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Background

Tuberculosis (TB) is a chronic disease caused by mycobacterium tuberculosis, which may infect almost all body tissues and organs, and pulmonary TB is the most common in clinic. TB continues to be a major public health issue worldwide, with 10.4 million new cases and 1.8 million deaths globally in 2015 [1]. Although the new cases of TB are decreasing slowly and its cure rate has gradually increased in China, China is still one of countries with high occurrence of TB, with about 0.918 million new cases in 2015, accounting for 8.83% of the global incidence and ranking third in the world [1]. The treatment of TB usually continues for a comparatively long period (at least 6–8 months), which form a significant obstacle for drug adherence of TB patients, and further lead to the failure of treatment and the formation of drug resistance [2,3]. To address poor adherence of TB patients, China has implemented the directly observed therapy (DOT) since 1991, with continuous expansion, DOT has covered the entire Chinese population since 2005 [4,5]. The essential component of DOT is the short course intermittent chemotherapy, which is the regimen of WHO for TB patients and requires that a supervised person directly observe that each patient takes drug as prescribed every other day for six to nine months [6,7]. Although the DOT has been executed for many years and has made much achievement in China, in practice there are still some factors limit the implement of DOT, such as it may bring the inconvenience to TB patients and increase the burden of health systems [8,9], increase the exposure risk to other health people [10,11], etc.

The rapid development of telecom industry, make short message service (SMS) become a promising approach to reinforcing patients' adherence and health awareness in many diseases, such as diabetes [12,13], cardiovascular diseases [14], etc. In this study, we explored the pulmonary TB patients' adherence and health awareness under the management of SMS, and provide scientific basis for promoting this therapeutic strategy in the future.

Material and Methods

Study design and patients

This is a prospective randomized, controlled study, in which six counties (districts) were selected from Anhui province, China by stratified cluster sampling method, and randomly divided into SMS group and control group. The informed consent was obtained from all patients. All the selected patients should be able to communicate via SMS by mobile phones of themselves or relatives living together. From December 1, 2014 to December 31, 2015, all the pulmonary TB patients of six counties (districts) eligible to the inclusion criteria (a. active

pulmonary tuberculosis patients, b. reach the age of 15, c. can read and understand the content of SMS, d. perfectly sane, e. volunteered for the study) were included in the study, otherwise excluded from the study.

Intervention measurement

All the patients received oral and written instructions about further management, patients in SMS group received SMS reminder during the whole anti-TB treatment period, patients in control group received the conventional DOT. The investigators sent SMS messages regularly (one SMS message per day, every morning) to remind SMS group patients taking the medicine on time and reexamining periodically, and sent TB-related knowledge for establishing healthy life mode.

The content of each SMS included: a). following the doctor's instructions, and taking medicine timely, b). reexamining sputum and chest X-ray periodically, c). covering nose and mouth when sneezing or coughing, and doing not spit everywhere, d). paying attention to washing hands, opening a window ventilated regularly, doing sports more, and improving resistibility, e). adhering to regular treatment, and most of TB patients can be cured.

Statistical analysis

Statistical analysis was implemented by using the Statistical Package for Social Science (SPSS) version 10.01 for Windows. We applied the Shapiro-Wilk test to check whether the data were approximately normally distributed. Continuous variables were presented as mean ±SD for normally distributed data or median (interquartile range, IQR) for non-normally distributed data. Categorical variables were described as frequencies and percentages. The difference between continuous variables in two groups was tested by t-test or Mann-Whitney U test, and that between categorical variables was tested by chi-square test. A two-sided $P<0.05$ was considered as statistically significant.

Results

In this study, a total of 350 patients were enrolled, and randomly divided into SMS group (n=160) and control group (n=190). The demographic characteristics of all patients were shown in Table 1, there were no significant differences in age, gender, weight, vocation and education background distribution between SMS group and control group. The completed treatment rate in the SMS group was significantly higher than that in control group (p=0.002), and both the missed dose rate and the interrupted treatment rate in the SMS group were significantly lower than those in the control group (p<0.001, p=0.001).

Table 1. The demographic characteristics of study subjects.

Characteristics	SMS group (n=160)	Control group (n=190)	*p* value
Age	47.59±13.42	50.39±17.13	0.09
Weight	54.9±10.12	56.03±8.57	0.26
Gender			0.100
Male	117	153	
Female	43	37	
Vocation			0.093
Farmer	119	153	
Worker	5	9	
Student	6	9	
Service personnel	11	11	
Others	19	8	
Education background			0.534
Primary school or below	77	97	
Junior high school	42	52	
High school	25	30	
College or above	16	11	

Table 2. Comparison of the treatment adherence and reexamination between two groups.

	SMS group (n=160)		Control group (n=190)		*p* value
Treatment adherence					
Missed the dose	30	(18.75%)	87	(45.79%)	<0.001
Interrupted the treatment	28	(17.50%)	62	(32.63%)	0.001
Completed the treatment	154	(96.25%)	165	(86.84%)	0.002
Reexamination					
Reexamined sputum after 2 months treatment	155	(96.88%)	167	(87.89%)	0.002
Reexamined sputum after 5 months treatment	148	(92.50%)	164	(86.32%)	0.064
Reexamined sputum after 6 months treatment	141	(88.13%)	132	(69.47%)	<0.001
Reexamined chest X-ray after 6 months treatment	137	(85.63%)	135	(71.05%)	0.001

There were significantly differences between SMS group and control group in reexamined sputum rate after 2-month treatment (96.88% *vs.* 87.89%, p=0.002), reexamined sputum rate after 6-month treatment (88.13% *vs.* 69.47%, p<0.001) and reexamined chest X-ray rate after 6-month treatment (85.63% *vs.* 71.05%, p=0.001). In spite of no significant difference between the two groups with regard to the rate of reexamined sputum after 5-month treatment, the rate of SMS group tended to be higher than that in control group (92.50% *vs.* 86.32%, p=0.064) (Table 2).

Discussion

Patients' survival and quality of life not only depend on proper diagnosis and effective medical treatment, but also are affected by patients' adherence to recommended treatment regimens. The advice given to patients by their physician or other healthcare provider to cure or control disease is often misunderstood, carried out improperly, forgotten, or even absolutely ignored, which will be a potential health threat and bring a heavy economic burden to patients [15–17]. And the treatment of pulmonary TB usually continues for a comparatively long period, which is a major obstacle to pulmonary TB

patients' adherence, and further lead to the failure of treatment and the formation of drug resistance [2,3]. In order to eradicate the pulmonary TB, China proposed China National Tuberculosis Prevention and Control Scheme in 1990 and has executed DOT since 1991, which has covered the entire population of China [4,5]. In practice, current studies reveal that there are still some limitations of this treatment strategy, such as it may cause the inconvenience of patients and overstretch the already overloaded health systems, put heavy burden on the patient's mental health and wage earnings [8,9], frequent commuting on public transport increases the exposure risk to other health people [10,11], the attitude and experiences of health workers toward the DOT implementation lack of incentive and motivation [7,18,19], etc. Rural China, account for 80% of national pulmonary TB cases, only less than 25% pulmonary TB patients practically received the entire DOT process when taking chemotherapy drugs [7,20–22].

In China, with the rapid development of telecom industry, mobile phones are widespread, and most of the family or individual own a mobile phone. Mobile service, particularly SMS, is ubiquitous and enables an automated system of reminders, thus it may provide a new promising approach of providing support to patients in rural and remote areas [23,24] and deliver frequent prompts and health information to improve adherence [12,13,25,26]. SMS has been increasingly utilized in many diseases to improving adherence and promoting health, such as diabetes [12,13,27], cardiovascular diseases [14,28], pancreaticobiliary diseases [29], etc.

In this study, we explored the effect of SMS on the management of pulmonary TB patients. After received the SMS reminder, the completed treatment rate of SMS group was significantly higher than those received conventional DOT, and both the missed dose rate and interrupted treatment rate of SMS group were lower than those in the control group, which suggests that compared with DOT, SMS reminding regularly could significantly increase the patients' adherence of anti-TB treatment. Furthermore, after a period of treatment, the reexamination rate of SMS group patients was significantly higher than that in control group, the most likely reason is that besides daily drug intake schedules, the SMS group patients could receive extra frequent prompts and health information, which gradually propel patients to practicing good habits and health awareness.

Several limitations in our study should be acknowledged. First, in addition to treatment factor, only age, sex, body weight, occupation and education level were considered in the comparison between intervention group and control group, there may be other potential confounding factors. Second, only six counties (districts) in Anhui Province were selected in this study, which may restrict the generalizability of our result, further studies with larger sample size in different areas are needed to confirm the findings.

Conclusions

Compared with DOT, SMS reminding regularly could significantly increase the completed treatment rate of TB patients and reduce their missed dose rate and interrupted treatment rate, and further enhance their reexamined awareness. Therefore, SMS may be a new promising therapeutic strategy on the management of TB for improving patients' adherence and health awareness.

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