Tuberculosis Control Priorities Defined by Using Cost-Effectiveness and Burden of Disease

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Objective To define TB control priorities using cost-effectiveness and burden of disease. **Methods** An assumed cohort of 2 000 cases was set up based on age-specific incidence of 794 newly registered smear-positive cases in Beijing in 1994. Prognostic trees and model diagrams of infectivity with natural history and DOTS intervention were constructed based on the epidemiological parameters. **Results** DOTS reduced 89.19 % of YLL, 78.90% of YLD, and 99.98% of infectivity BOD. One DALY could be saved with 45.70 Yuan by DOTS with 3% discount. Sensitivity analysis showed that discount had effect on CER. Weight of age was insensitive to CER. The higher the DOTS cured rate, the more the cost-effectiveness. **Conclusions** DOTS is a good cost-effectiveness TB control strategy. Cost-effectiveness and burden of disease can be used to define TB control priorities.

Key words: Tuberculosis (TB); Burden of disease (BOD); Disability adjusted life year (DALY); Cost-effectiveness ratio (CER)

INTRODUCTION

Tuberculosis (TB) is an infectious disease with single pathogen causing the largest number of deaths and also a serious problem in public health in developing countries, but it is facing the challenge of public health all over the world[1]. Monitoring for global TB sponsored by WHO indicated that one person was infected with tubercle bacillus every second in the world, and death of TB in 1998 was more than any year in the history resulting in a lot of disability patients. Therefore, it is of importance and immediate significance to evaluate the burden of TB and analyze their cost-effectiveness of different intervention.

In narrow sense, the burden of disease (BOD) is defined by patient death and disability due to the disease. In broad sense, BOD is defined by social burden due to the disease, such as the burden to relations and friends of the patient, in addition to patient death and disability.

Disability adjusted life year (DALY) is a new indicator for the measurement of the

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burden of disease, which provides us an effective method to evaluate the burden of disease lived with disability, and consists of two parts. One is years of life lost to premature mortality (YLL) and the other is years lived with disability (YLD)[2-4]. In this study, the BOD of TB includes its infectious BOD, in addition to its YLL and YLD.

MATERIALS AND METHODS

An assumed cohort of 2 000 cases was set up based on age-specific incidence of 794 newly registered smear-positive cases in Beijing in 1994. Prognostic trees and model diagrams of infectivity with natural history and DOTS intervention were constructed based on the epidemiological parameters. A flow chart of cost accounting was constructed based on the expenses for drugs, chest X-ray films, sputum smear and cultures for the patients. The effectiveness of intervention for TB with DOTS was estimated using its natural history as control[5,6].

Epidemiology data under natural history and DOTS intervention see references 5 and 6.

RESULTS

BOD Under the Natural History

From Table 1, the life lost of the 2 000 cases cohort is 3 7667.18 DALYs under natural history, among which, 65.42 % is to its death, 5.01% to its disability, and 29.57% to its infectivity BOD.

TABLE 1

BOD Under Natural History

Age Group	YLL	YLD	Infectivity YLL	Total DALY
5~	193.33	8.74	87.40	289.47
15~	20025.28	1376.06	9053.07	30454.41
45~	2678.61	241.14	1210.95	4130.70
60~	1744.10	260.03	788.47	2792.60
Total	24641.32	1885.97	11139.89	37667.18

BOD Under DOTS Intervention

From Table 2, the life lost is 2 663.75 DALYs under DOTS intervention, among which,

TABLE 2

BOD Under DOTS Intervention

Age Group	YLL	YLD	Infectivity YLL	Total DALY
5~	17.76	1.83	0.01	19.60
15~	1839.26	290.23	1.91	2131.39
45~	246.02	50.92	0.33	297.27
60~	160.19	54.93	0.36	215.48
Total	2263.23	397.90	2.61	2663.75

84.96 % is to its death, 14.94% to its disability, and infectivity BOD nearly to zero. Compared with natural history, the total life lost is declined 92.93%, YLL 89.19%, YLD 78.90%, and infectivity BOD 99.98% under DOTS intervention. DOTS intervention greatly reduced infectivity BOD.

Effectiveness of TB-cases Under DOTS

As is shown in Table 3, 35 003.43 DALYs may be saved under DOTS intervention, among which, 63.93% of YLL, 4.25% of YLD, and 31.82% of infectivity are saved respectively.

TABLE 3

Effectiveness of TB-cases Under DOTS (Saved DALY)

Age Group	YLL	YLD	Infectivity YLL	Saved Total DALY
5~	175.57	6.91	87.39	269.87
15~	18 186.02	1 085.83	9 051.16	28 323.01
45~	2 432.59	190.22	1 210.62	3 833.43
60~	1 583.91	205.10	788.11	2 577.12
Total	22 378.09	1 488.06	11 137.28	35 003.43

Cost of TB-cases Under DOTS Intervention

Table 4 shows that the total cost of 2 000 cases of the study cohort is 1 599 700 Yuan, among of which, initial cost is 1 133 200 Yuan (70.84%), retreated cost 84 500 Yuan (5.28%), and chronic 5 years 382 000 Yuan (23.88%).

TABLE 4

Cost of TB-cases Under DOTS Intervention (10 Thousands)

Age Group	Initial	Retreated	Chronic 5 Years	Total
5~	0.51	0.04	0.17	0.72
15~	69.47	5.18	23.42	98.07
45~	16.54	1.23	5.58	23.35
60~	26.80	2.00	9.03	37.83
Total	113.32	8.45	38.20	159.97

Cost-effectiveness Ratio of TB-cases Under DOTS

As is shown in Table 5, the cost-effectiveness ratio is 45.70 under DOTS intervention. It means that one DALY can be saved with 45.70 Yuan by DOTS with 3% discount.

Sensitivity Analysis

Effect on CER discount and weight of age factor. As is shown in Table 6, discount exerts more effect on CER. CER is 27.80 with zero discount rate and 92.69 with 10% of discount rate, and the latter is three times of the former. The more the discount, the more the CER. But weight of age is insensitive to it. CER has little effect on CER without regard to

weight of age. From Table 7, we see that the select of discount is very critical, especially infectious diseases, such as TB.

TABLE 5

Cost-effectiveness Ratio (CER) of TB Cases Under DOTS Intervention

Age Group	Cost (10 Thousand Yuan)	Net Effectiveness (Saved Total DALY)	CER Cost / (Net Effectiveness)
5~	0.72	269.87	26.68
15~	98.07	28 323.01	34.62
45~	23.35	3 833.43	60.91
60~	37.83	2 577.12	146.79
Total	159.97	35003.43	45.70

TABLE 6

Effect on CER Discount (i) and Weight of Age Factor (k)

Age Group	Discount			Age Weight Factor $k=0$
	r=0.10	*r=0.03*	*r=0*	
5~	70.81	26.67	12.57	33.84
15~	74.07	34.62	20.27	37.95
45~	112.40	60.92	42.18	47.90
60~	205.70	146.80	124.31	88.73
Total	92.69	45.70	27.80	45.46

Effect on CER by DOTS cured rate. As is shown in Table 7, the higher the DOTS cured rate, the less the cost-effectiveness ratio, and the more the cost-effectiveness. When cured rate approached to 95%, no more than 33 Yuan saved one DALY. Only if 85% of cured rate by WHO recommend, 60 Yuan would save one DALY. In a word, it would reduce CER and increase the cost-effectiveness if the cured rate is increased under DOTS.

TABLE 7

Effect on CER by DOTS Cured Rate

Age Group	Cured Rate (%)		
	85	90	95
5~	34.59	26.67	18.82
15~	44.91	34.62	24.42
45~	79.05	60.92	42.96
60~	190.63	146.80	103.44
Total	59.29	45.70	32.23

DISCUSSION

The value of TB control programme in developing countries remains an issue of debate. This study used a new index——disability adjusted life year (DALY) to evaluate the burden

of disease for smear-positive TB cases, especially to compare the cost-effectiveness of DOTS and natural history.

The methodology used in the study is basically a simple form of risk assessment involving minimal data to estimate and illustrate potential burden of disease and the effect of different interventions. To make it simple, the prognosis trees and model diagrams of infectivity under natural history and DOTS were designed on the basis of assumptions without considering the implications of multi-drug resistance TB and other risk factors [4-6].

Sensitivity analysis showed that discount had more effect on CER. CER was 27.80 with zero discount rate and 92.69 with 10% of discount rate, and the latter was three times of the former. The higher discount, the more CER. But weight of age was insensitive to it. The selection of discount was very critical for infectious disease.

In this study, an assumed cohort was used based on recent data obtained from a large cohort of newly registered smear-positive cases in Beijing in 1994. Although the method is basically a form of risk assessment requiring minimal data to estimate and illustrate potential disease burden under natural history and DOTS intervention, as well as the cost-effectiveness of DOTS intervention, the findings may be generalized to different areas and populations, and even to different nations in the world under the prerequisite that data of age- and sex-specific incidences and mortality rates are available. It is believed that the study will provide a rationale for active TB surveillance programs with DOTS. It is a good cost-effectiveness TB control strategy.

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