



Cost of Tuberculosis Treatment: Evidence from Iran's Health System

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Objectives: This study aimed to estimate the cost of smear-positive drug-susceptible pulmonary tuberculosis (TB) treatment of the patients in the Azadshahr district, Golestan Province, Iran.

Methods: In this retrospective study, all new smear positive pulmonary TB patients who had been registered at the district's health network between April, 2013 and December, 2015 and had successfully completed their treatment were entered into the study (45 patients). Treatment costs were estimated from the provider's perspective using an activity-based costing (ABC) method.

Results: The cost of treating a new smear-positive pulmonary TB patient was US dollar (USD) 1,409.00 (Iranian Rial, 39,438,260), which can be divided into direct and indirect costs (USD 1,226.00 [87%] and USD 183.00 [13%], respectively). The highest cost (58.1%) was related to care and management of TB patients (including 46.1% human resources costs and 12% directly-observed treatment, short course implementation) and then respectively related to hospitalization (12.1%), supportive activity centers (11.4%), transportation (6.5%), medicines (5.3%), and laboratory tests and radiography (3.2%).

Conclusion: Using disease-specific cost studies can help the healthcare system management to have correct insight into the financial burden created by the disease. This can subsequently be used in prioritization, planning, operational budgeting, economic evaluation of programs, interventions, and ultimately in disease management.

Key Words: public health, tuberculosis, cost analysis

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INTRODUCTION

Tuberculosis (TB) is an infectious bacterial disease caused by *Mycobacterium tuberculosis* [1] and is considered one of the oldest human diseases causing mortality and disability among humans throughout history. Even today, despite knowing the cause of disease, the availability of vaccines and highly effective drugs for TB, the disease is still one of the major global health problems, especially in developing countries [2]. About one-third of the world's population has latent TB and in 2015, 5.9 million people became symptomatic and 1.4 million died from the disease [3]. The incidence of TB in Iran has been estimated as 16 per 100,000 population in 2015 [3] with the highest number of patients coming from the Golestan and Sistan-and-Baluchestan Provinces [4].



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The objective of a TB control plan in Iran is consistent with the goal of the World Health Organization (WHO) to a 90% reduction in TB deaths and an 80% reduction in the TB incidence rate by 2030 [3]. Iran's strategy in the TB control program is based on prevention through the BCG (bacille Calmette-Guerin) vaccination (started in 1984) and treatment through directly-observed treatment (DOTS) since 1997 [5]. With the introduction of the DOTS II or the Stop TB Strategy and progressing from Stop TB strategy to End TB in 2015 [6], the Iranian strategy for fighting TB has been revised and new strategies have been adopted.

The diagnosis and treatment of TB requires financial resources and scarcity of resources for establishing and maintaining health services centers, which has caused the government and service providers to conduct economic studies pertaining to health care issues [7]. Health economic studies provide useful information to managers and decision makers for efficient use of organization resources [8,9]. A cost study is one of the most important health economic studies and is a foundation for economic evaluations [10]. The cost study refers to the analysis of the costs of a healthcare intervention (action) costs; therefore, analyzing the service unit costs to achieve a clear-cut picture of the costs' trend and operational budgets in addition to effective use of the resources in recent years in terms of the healthcare economy have been considered [11].

Accordingly, the implementation and deployment of the cost system and calculation of the unit cost of services is necessary and unavoidable and is also vital for long-term planning of the healthcare system [12]. In this regard, disease-specific costing can provide valuable information for health services providers, policy makers, and insurance organizations concerning the required resources for delivery of a specific service, financing assessment, and the existing deficiencies in service provision or identification of areas for cost containment [11,13,14].

Studies from developed and developing countries showed the average treatment cost of a patient with drug-susceptible TB ranging from US dollar (USD) 34.00 to 12,800.00 [15–21]. It seems the difference between the TB treatment costs resulted from differences in health care systems, perspectives of cost estimation (either provider or patient), cost components, and calculation methods in addition to the data used by researchers and others. Therefore, such information is not transferrable

to other countries, and the application of data resulting from such studies is exclusively useful for the country under study [15]. Considering that no comprehensive study on TB treatment costs have been conducted in Iran [22,23], the present study was aimed at estimating the costs of smear-positive drug-susceptible pulmonary TB treatment for patients in the Azadshahr district, Golestan Province, in the northeast of Iran.

MATERIALS AND METHODS

1. Study sample

This retrospective study was conducted in the healthcare network of Azadshahr District, Golestan Province of Iran. The study population included all TB patients under treatment in this network; however, only those patients suffering from smear-positive pulmonary TB who had been registered between April, 2013 and December, 2015 and have successfully completed their treatment were entered into the study (45 patients).

2. Costing method

Cost of treatment was done from the provider's perspective, and the activity-based costing (ABC) method. The ABC is one of the managerial tools developed by Kaplan [24] for establishing capability in determining actual costs of producing a product or service. In this method, the assumption is that the cost allocated to the products is based on the consumption of activities and the direct and indirect consumption of resources, which are part of the activities. In other words, the consumption of activities creates value in the product [24]. In the present study, considering the type of activity performed in any unit pertaining to the implementation of the national TB program in the district's health network, the understudy units were divided into three activity centers; 1) final, 2) intermediary, and 3) supportive. The final activity centers are units directly engaged in the service delivery process to the patients, while the intermediary activity centers are the units that provide services to the final activity units and sometimes directly provide patient services. The supportive activity centers are those units not directly involved in providing patient service; rather they perform general services and give support to the final and intermediary activity centers. **Table 1** shows the classification of activity centers of the TB treatment

Table 1. Activity centers of tuberculosis (TB) treatment's process at the district's health network

Final activity centers	Intermediary activity centers	Supportive activity centers
Disease unit of rural & urban health centers	Radiology & TB laboratories	Administrative & Financial units
TB office of district's health network	Hospital	Security & Maintenance units

process at the district's health network.

In this study, the total cost incurred by the service provider in TB treatment was divided into two parts; 1) direct and 2) indirect costs. Direct costs resulting from the direct provision of medical services to the patients [25], which include medicines, laboratory and radiology services, general physicians and specialists' consultations, consumable materials, and transportation in addition to salaries of the staff who are directly involved in TB treatment. Indirect treatment costs are referred to as costs not directly identified with a particular activity, service, or product [25,26], and they include depreciation costs (building, equipment, and office furniture), the costs incurred by supportive activity centers (security, maintenance, administrative, and financial affairs), and energy costs. Cost calculations are described in subsequent sections.

3. Cost calculation

1) Human resources' costs

To calculate the cost of human resources, a time and motion study was used. For this purpose, an interview with TB treatment program experts in the district's health network, while complying with related guidelines, identified and described the main activities of each one of the services provided for the TB affected patients. Afterwards, these activities were performed by six TB caregivers and the time spent for completion of each individual activity was recorded using a stopwatch, and finally, the average time of each activity was obtained. To equate monetary value with time, the overall amount of money received (salaries and bonuses) was divided by the number of working days assuming seven hours of work per day (minus the official holidays) and the annual monetary value of a working hour and minute of a TB caregiver was obtained. The expenditure on human resources for TB treatment was calculated through multiplication of the employee's average time spent in TB-related activities by multiplying it with the monetary value of a minute.

2) DOTS implementation cost

DOTS implementation cost is the amount of money paid to the caregiver for direct observation of the patient's consumption of anti-TB drug(s). The average cost of DOTS implementation for each patient was obtained through multiplication of the average execution days of DOTS in the tariff as determined by the Ministry of Health.

3) Medicine, laboratory services, radiology, out-patient visits, and hospitalization costs

Data pertaining to the patient's use of medicines, laboratory services (sputum smear, cultures, and drug sensitivity testing),

radiology and out-patient consultation (by general physicians and specialists), and hospitalization services were obtained from the patient records. Subsequently, by multiplying the usage rates in unit price, the costs were estimated. The price of medicines, laboratory services, radiology, and out-patient visits were obtained from the Ministry of Health. The hospitalization cost of the patients was extracted from the patient records in the hospital.

4) Consumable materials and vehicle costs

The consumable items' usage rate (paper, gloves, masks, and other supplies) and the vehicle (for follow-up and monitoring the treatment process) were obtained from the patient records. The unit price of the consumable materials and transportation was obtained from the procurement and transportation departments of the district's health network. By multiplying the vehicle and consumable materials' usage in the unit price of the used items, the costs were calculated.

5) Depreciation costs

The depreciation costs of a building based on the area of each activity unit and the depreciation cost of the equipment (computer systems, printer, fax, office furniture, and heating-cooling systems) was calculated based on the existing list of the equipment in each activity unit using the straight line depreciation method:

Annual depreciation cost =

$$\text{current asset value} - \text{salvage asset value} / \text{useful life}$$

The useful life for a building and equipment was considered 30 and 5 years, respectively.

6) Energy and general consumable items cost

The cost of energy included water, electricity, gas, and telephones. Total paid costs for the earlier mentioned items were added to each other, and the share of each care unit was determined in proportion to the area of each unit space.

7) The costs imposed by supportive activity centers

The costs resulting from security, maintenance, and financial and administrative affairs in the supportive activity centers were estimated separately from the final activity centers in terms of consumable items, human resources, and building and equipment depreciation and energy. Using specific cost drivers, the estimated costs were then allocated to the final activity centers (TB disease treatment and care units). The specific cost drivers for allocating the annual costs of security and maintenance units were equal to the space of the TB units in health centers. For administrative and financial units the cost driver was the number

of personnel.

All costs were calculated in Iranian Rial (IRR) and converted to USD according to the 2015 exchange rate of USD 1 = IRR 28,000 [27]. The study data were entered into Excel software (Microsoft, Redmond, WA, USA) and analyzed using descriptive statistics methods. In undertaking the present study, ethical points, including the confidentiality principle regarding personal ID and clinical information of the patients, descriptions, and explanations of the goals and importance of the study to officials of the district's health network and attracting their cooperation, and a provision for giving the related authorities the study results, were observed.

RESULTS

1. Resources and service utilization patterns of treatment for TB patients

The recommended treatment for patients with smear-positive drug-susceptible pulmonary TB consisted of two stages: 1) intensive phase treatment (for at least two months with four antibiotics including rifampicin, isoniazid, and pyrazinamide and isoniazid) and 2) continuation phase treatment (for at least four months with two antibiotics, which include rifampicin and isoniazid). The average number of days the patients are required to take the drugs was 195 days (range, 180–243 days). The average number of days of DOTS implementation was 158 days per patient (60 days during the intensive and 98 days in the continuation phase treatment). In addition, 27% of TB affected patients were hospitalized with the average length of stay being 1.8 days. The average number of X-rays, smear sampling, and preparation of cultivation was 1.7, 4.4, and 0.4 per patient, respectively. During his/her treatment period, each patient was visited nine times

Table 2. Resource and services utilization pattern

Resource & Services	Total utilization	Mean utilization (per patient)
DOTS implementation (day)	7,090	158
Sputum smear test (n)	198	4.4
Culture (n)	18	0.4
Livers' enzyme test (n)	59	1.3
Chest X-ray (n)	79	1.7
General physicians consultation (n)	398	8.8
Specialist physicians consultation (n)	49	1.1
Hospitalization (day)	82	1.8
Drug (tablet)	33,337	741

by a general physician and once by a specialist. Also, the average number of combination drugs used per patient per day was 3.8 tablets. During the intensive phase, continuation phase, and the entire treatment period, the number of drugs were 266, 475, and 741 combination of tablets, respectively (Table 2).

2. The cost of treatment of a smear-positive pulmonary TB patient

In this study, the final cost of treatment of a new smear-positive pulmonary TB patient from the provider's perspective was estimated as equal to USD 1,409.00 (IRR 39,438,260) including USD 1,226.00 direct costs (87%) and USD 183.00 indirect costs (13%). The highest costs were related to human resources with 58.1% (including 46.1% human resources costs and 12% DOTS implementation) and then respectively related to hospitalization costs (12.1%), costs are attributed to supportive activity centers (11.4%), transportation (6.5%), medicines (5.3%), and laboratory tests and radiography (3.2%) (Table 3).

We found that the largest share of treatment costs was related to the final, intermediate, and supportive activity centers with USD 1,032.00, 215.00, and 162.00, respectively.

Table 3. Cost components of tuberculosis treatment

Cost component	Cost per patient (IRR)	Cost per patient (USD)	Percent of total cost
Direct cost			
Human resource	22,908,642	818	58.1
Medicines	1,826,966	65	5.3
Physicians consultation	784,000	28	2.0
Hospitalization	4,765,169	170	12.1
Laboratory & radiology	1,266,264	45	3.2
Consumable materials	201,134	7	0.6
Transportation	2,556,500	91	6.5
Total direct costs	34,308,674	1,226	87.0
Indirect cost			
Depreciation costs	474,926	17	1.2
Energy	160,170	6	0.4
Supportive activity centers costs	4,494,489	161	11.4
Total indirect costs	5,129,585	183	13.0
Total cost	39,438,260	1,409	100

Human resource includes manpower and directly-observed treatment implementation; Depreciation costs includes building, equipment and office furniture; Supportive activity centers costs includes security, maintenance, administrative and financial affairs. IRR, Iranian Rial; USD, US dollar.

DISCUSSION

According to the findings of this study, the cost of treatment of a new smear-positive pulmonary TB patient from the provider's perspective was estimated to be about USD 1,409.00 from which 87% and 13% are related to the direct and indirect costs, respectively. In studies conducted in Malaysia (2014), Yemen (2012), and Germany (2012), the treatment costs for a patient with smear-positive drug-susceptible pulmonary TB from the provider's perspective were USD 325.00, 34.00, and 7,931.00, respectively [15,18,28]. In two review studies, the treatment costs for a patient with smear-positive pulmonary TB in countries with upper-middle income was estimated at about USD 840.00 [21] and 847.00 [29], which was close to our findings. It seems that the different results are attributable to the different strategies adopted by different countries in the management of the disease (such as hospitalization or out-patient treatment, performing daily DOTS), study approaches (from the perspective of the provider, patient, or the society), costing method, and differences in cost groups (such as personnel costs and particularly drug costs). Accordingly, a comparison of the study results does not seem logical, and the findings of any study can only be generalized based on the same setting and country.

Human resource costs accounted for 58.1% of the total costs of treatment. In similar studies, the personnel costs allocated the largest share of total treatment cost of TB patients to themselves. In a Malaysian study, this share was 69.9% [15], and in other studies from Iran and Thailand, the highest share of the costs was related to personnel costs [22,30], which were consistent with our findings. The reason for the high personnel costs in our study could be attributed to the lengthy treatment period and the emphasis on disease management programs, including continuous monitoring of the treatment process to prevent drug-resistant forms in the patients [31].

Hospitalization costs accounted for 12.1% of the total treatment costs. In Malaysia, it was found that 10.5% of the treatment costs for TB patients were pertinent to hospitalization [15]; this is consistent with this study's findings. In a review study [21] and in a study conducted in Germany [28], hospitalization consisted of 33% and 86% of total treatment costs, respectively. These findings were inconsistent with ours. It seems that these differences resulted from the difference in strategies adopted for management and mitigation of the disease (such as hospitalization of TB patients or treatment of out-patients) in various countries.

The drug cost in this study was 5.3% of the total costs. The findings of a study showed that 9.2% of the total sum of treatment costs of TB drug-susceptible patients is related to the drug costs [21]. In addition, studies conducted in Germany [28] and

Malaysia [15] showed that the drug component from the treatment costs was 9.9% and 21.6%, respectively. These findings were not consistent with our study findings. In our study, it appears that the lack of domestic production of anti-TBs drugs and import from the WHO certified companies with low tariffs were the reason for the low number of pharmaceuticals.

The cost of laboratory tests and radiography amounted to a total of about 3.2% of the total costs. In a review study by Laurence et al. [21], the tests and radiography costs amounted to 5.9%, which were roughly consistent with the finding in our study. In other studies, the cost of laboratory tests and radiography constituted 33% and 22% of the treatment costs, respectively, of TB out-patients [15,28]. The share of this cost group was estimated as more than 13% in Thailand and Yemen [18,30], which was inconsistent with our study's findings. It seems that the difference in tariffs and drug prices and the diagnostic tests in addition to the adopted cost approach was the most important cause of the differences in the findings of this cost group.

The cost of a physician's visit for smear-positive drug-susceptible pulmonary TB patients in our study was 2% of the total treatment costs. In previous studies, the cost of physicians' visits during treatment periods were 19% [21], 8% [28], and 20% [30]; this was inconsistent with this study's findings. In this study, the specialist's visit costs not covered by the anti-TB program and the patient out-of-pocket payments not calculated were the reason for the low treatment costs.

Our study has several limitations. First; in this study, only the cost of treatment for smear-positive drug-susceptible pulmonary TB patients was estimated. Although, from the public health perspective, the group of patients with smear-positive pulmonary TB attached more importance and constituted the vast majority of TB patients. This group is considered the best criterion for evaluating the performance of health systems in TB disease management programs [15], but the results obtained from this study cannot be generalized to other TB cases such as retreatment cases and those with multidrug-resistant TB that basically have different consumption patterns. Second, considering the extent of financial burden created by TB in different dimensions (for the patient, provider, and society) in addition to the time limits, this study was conducted only from the providers' perspective and all cost estimation; therefore, it does not comprise all costs caused by TB. Finally, we were faced with the issue of deficiency in registration, restrictions on segregation, and access to some data. There is also the problem of access to accurate data for disease-specific costs in low-income and middle-income countries [11].

Using disease-specific costing studies can help the management of health systems to have a correct insight of the financial burden created by the disease, and this can subsequently be used

in prioritization, planning, operational budgeting, economic evaluation of programs and interventions, and ultimately in disease management. It is suggested that due to the patient-centered approach recommended by WHO for reducing costs, the use of methods such as treatment three times per week and weekly package treatment with daily dose and community-based DOT in the continuation phase of treatment are considered. Since significant portions of costs in the health centers are related to personnel costs and transportation vehicles, it is suggested that TB laboratories should be established in suitable geographic locations.

CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

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