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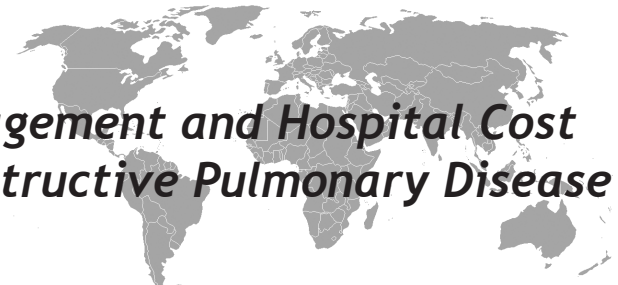
Original Article



Activity-Based Costing Management and Hospital Cost in Patients with Chronic Obstructive Pulmonary Disease

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ABSTRACT

Objective: *Chronic obstructive pulmonary disease (COPD), one of the most important causes of morbidity and mortality worldwide, is an important economic burden due to hospitalizations, incapacity to work, and disability. The present study aimed to demonstrate one-year activity-based costing of services provided by service-providing centers of Yedikule Chest Diseases and Thoracic Surgery Training and Research Hospital, which provides services for a wide region, and to present the share of COPD in this cost.* ***Method:*** *Income and expense cost sheets of the year 2011 of the hospital was reviewed. The activity-based costing system was used for calculations. After the identification of the main service centers's expenses of the hospital,the annual expenditure of each unit was calculated. The cost of COPD patients was calculated based on the expenditures of the units caring for COPD patients. The cost per unit of services like radiography, laboratory and pulmonary function tests was calculated and added to the cost of COPD patients.* ***Results:*** *Annual cost according to the activity-based costing system was found to be 3,839,788.32 US Dollars ($) for COPD patients examined and treated as inpatient (2,531,290.9 $) , or at emergency room (586,170.7 $) , or at respiratory intensive care unit (419,282.11$) , or at polyclinics (303,044.5 . It accounted for 19.5% of one-year hospital cost (total annual hospital cost was 20,055,400.8 US Dollars).* ***Conclusion:*** *The rising economic burden of COPD corralates with acute exacerbations. As COPD is a high-cost disease, measures should be of priority to reduce economic burden of the disease.*

Key words: *Chronic obstructive pulmonary disease, activity-based costing, cost, economic burden*

Kronik Obstrüktif Akciğer Hastalığı (KOAH) Olan Hastaların Faaliyet tabanlı Maliyet Yöntemi ile Hastane Maliyeti

ÖZET

Amaç: *Tüm dünyada dünya çapında en önemli hastalık ve ölüm nedenlerinden biri olan kronik obstrüktif akciğer hastalığı (KOAH), aynı zamanda hastaneye yatışlar, iş göremezlik ve disabilite gibi nedenlerle önemli bir ekonomik yüktür. Çalışmamızda geniş bir bölgeye hizmet veren Yedikule Göğüs Hastalıkları ve Göğüs Cerrahisi Eğitim Araştırma Hastanesinin, hizmet üreten merkezlerinin ürettikleri hizmetlere göre bir yıllık faaliyet tabanlı maliyeti ve KOAH'ın payının gösterilmesi hedeflenmiştir.* ***Yöntem:*** *Hastanenin 2011 yılı gelir ve gider kayıtları incelendi.Hesaplamalar için faaliyet tabanlı maliyet sistemi kullanıldı. Hastanenin esas hizmet merkezleri belirlendikten sonra her bir bölümün yıllık gideri hesaplandı.KOAH'lı hastaların maliyeti Koah hastalarının bakımını yapan ünitelerin giderlerine göre hesaplandı. Radyoloji, laboratuar ve solunum fonksiyon testi gibi her servisin maliyeti hesaplanarak KOAH'lı hastaların maliyetine ilave edildi.* ***Bulgular:*** *Bir yıl içinde yatarak (2,531,290.9 $), acil serviste (586,170.7 $), solunum yoğun bakımda (419,282.11$) ve polikliniklerde (303,044.5) tetkik ve tedavi edilen KOAH'lı hastaların faaliyet tabanlı maliyetleme sistemine göre yıllık maliyeti 3.839.788,32 $ bulunmuştur. Bu da bir yıllık hastane maliyetinin %19,5'i (yıllık hastane maliyeti 20,055,400.8 US Dollars) olarak hesaplanmıştır.* ***Sonuç:*** *KOAH'ın ekonomik yükünün artışı alevlenmelerle koreledir.Yüksek maliyetli bir hastalık olan KOAH'ta; hastalığın ekonomik yükünü azaltmak için, önlemler öncelikli olmalıdır.*

Anahtar kelimeler: *Kronik obstrüktif akciğer hastalığı, faaliyet tabanlı maliyet, maliyet, ekonomik yük*

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INTRODUCTION

Accurate calculation of cost of a service plays a role not only in the control and inspection of costs, but also in effective allocation of resources. Numerous types of cost centers are established according to the structural characteristics of enterprises that provide health care services and this makes it difficult to calculate the costs accurately. Inadequate costing particularly in non-profit public hospitals causes ineffective use of resources, inadequate cost control, and increased burden on government. Cost of illness can be evaluated in two separate classes: direct health expenditures that comprise expenses for diagnosis and treatment and indirect health expenditures caused by illness-related labor loss. Direct costing includes expenses for medications, diagnostic analyses, disease follow-up, polyclinic and emergency services, and hospital stay. Cost of hospital stay accounts for the substantial proportion of direct health expenditures. Indirect costing includes loss of labor and production due to activity restriction, disablement, and early death (1,2). In Turkey, there is limited number of studies on cost analysis.

Chronic obstructive pulmonary disease (COPD) is one of the most important causes of morbidity and mortality worldwide. Additionally, COPD is an important economic burden due to hospitalizations, incapacity to work, and disability. Its prevalence is reported between 0.2% and 37% depending on diagnostic and classification methods of COPD across the countries and populations (3). Among the causes of death, COPD ranks fourth all over the world and third in the countries with moderate level of income (4). Direct costs such as diagnostic and treatment expenditures and indirect costs such as economic results of disability, labor loss, early death, and family expenses for disease are quite high for COPD. In the developed countries, cost of COPD exacerbations has an important place in health budget. In the European Union countries, it has been reported that respiratory diseases-related cost accounts for 6% of overall health service budget and expenses secondary to COPD accounts for 56% (38.6 billion Euros) of this cost. According to the 2002 data, in the USA, COPD-related direct cost was 18 billion dollars and indirect cost was 14.1 billion dollars. Relevant cost increases as the severity of disease increases (5).

The present study aimed to demonstrate one-year activity-based costing of services provided by service-providing centers of Yedikule Chest Diseases and Thoracic Surgery Training and Research Hospital, which provides services for a wide region using the most advanced technical equipments, and to present the share of COPD in this cost.

MATERIAL AND METHODS

Yedikule Chest Diseases and Thoracic Surgery Training and Research Hospital is one of the largest hospitals of Istanbul with a mean daily number of 800-850 outpatients and with 400-bed capacity and approximately 700 employees (including security, cleaning, data entry, etc. services that are provided via service procurement). Income and expense cost sheets of the year 2011 was reviewed to calculate one-year hospital cost. Payroll records for salary and working fund, supplies, and technical service records of the same year were obtained from relevant units. Quantity of health services was determined using the hospital information management system (HIMS) and hospital records. Ethics approval was obtained from the Yedikule Chest Diseases and Thoracic Surgery Training and Research Hospital Ethics Board for this retrospective study (reference number: 37/2012). Administrators of expense centers were also consulted when necessary. Determining expense centers is one of the most important steps in cost calculation.

Main Service Centers

These are the places where health services are produced and these comprise inpatient and outpatient service centers. Based on the services and physical structure of our hospital, units providing services for inpatients (operating room, chest diseases, tuberculosis, thoracic surgery, respiratory intensive care, surgical intensive care, and chemotherapy), units providing services for outpatients (emergency room and polyclinics), and administrative center were classified as main service centers.

Auxiliary Service Expense Centers

Although these are the auxiliary expense places for main service centers, these are income-generating cost centers. Expenses arising from these service centers can be incurred on patients without subjecting to a second allocation since there might be patients that would want to benefit only from this service. Biochemistry, microbiology, pathology and pulmonary function laboratories, as well as radiology, tomography and bronchology centers were classified as auxiliary service expense centers. Costs of these centers and the unit prices for the services they

Table1. Total expenses in the first allocation according to the service units in the hospital

	Expense item (in US Dollars)									
Service Unit	Personnel	Heating	Cleaning	Electricity/ Water	Communication	Maintenance/ Repair	Stationery	Medication/ medical consumables	Depreciation	Total
Chest diseases	4,052,021.27	117,194.61	17,880.33	97,808.87	17,624.55	24,870.97	34,821.07	2,988,082.73	65,077.34	7,415,381.74
Thoracic surgery	1,144,938.04	23,181.35	3,536.76	31,121.07	5,874.85	9,949.41	8,221.79	723,284.30	21,854.30	1,971,961.87
Tuberculosis	204,486.91	3,679.57	561.39	10,670.06	783.32	2,984.43	967.23	59,408.71	3,763.82	287,305.44
Internal ER	475,382.42	13,614.44	2,077.15	10,670.06	1,958.24	2,984.43	9,672.35	557,125.18	3,763.82	1,077,248.09
Surgical ER	417,479.58	3,863.55	589.46	10,670.06	1,958.24	2,984.43	4,836.44	139,281.32	3,763.82	585,426.90
Respiratory ICU	340,885.71	5,519.37	858.50	53,350.29	783.32	7,185.62	1,934.47	53,208.92	14,569.59	478,295.79
Surgical ICU	248,374.61	5,519.37	858.50	53,350.29	783.32	9,286.21	1,934.47	9,473.56	22,232.50	351,812.83
Polyclinics	720,173.52	13,798.42	2,105.21	12,448.39	783.32	2,984.43	9,672.35	538.63	14,569.60	777,073.87
Operating room	443,985.59	7,727.12	1,178.92	21,340.11	783.32	231,282.77	483.58	413.95	20,640.18	727,835.54
Other polyclinics	898,445.88	7,727.12	1,178.92	12,448.39	1,566.64	2,984.43	4,836.44	8,800.28	15,783.78	953,771.88
Chemotherapy	132,442.22	4,415.49	673.67	10,670.06	783.32	2,984.43	967.23	6,975.7	3,763.82	163,675.97
Laboratory	211,069.82	3,311.62	508.86	22,229.28	783.32	55,512.34	2,901.77	974,969.23	75,276.82	1,346,563.06
Tomography-US	199,022.21	3,679.57	561.39	22,229.28	783.32	44,507.74	483.58	84,163.95	69,205.38	424,636.42
Radiology	33,141.00	3,679.57	561.39	21,340.11	783.32	11,641.03	483.58	126,245.93	58,278.26	256,154.19
Pathology	225,358.74	2,759.68	421.04	10,670.06	783.32	2,984.43	967.23	167,989.98	6,070.65	418,005.13
Bronchology	171,621.19	3,679.57	561.39	10,670.06	783.32	235,186.61	967.23	145,129.69	20,640.18	589,239.24
Pulmonary function	54,995.03	3,311.62	505.25	10,670.06	783.32	2,984.43	967.23	33.09	6,070.65	80,320.68
Administration	1,680,403.34	82,427.44	12,575.18	22,229.28	39,948.91	119,380.43	11,607.15	0	182,119.50	2,150,691.23
Total	11,654,227.08	309,089.48	47,193.31	444,585.78	78,331.27	772,678.57	96,725.19	6,045,125.15	607,444.01	20,055,400.8

ER, Emergency Room; ICU, Intensive Care Unit; US, Ultrasonography

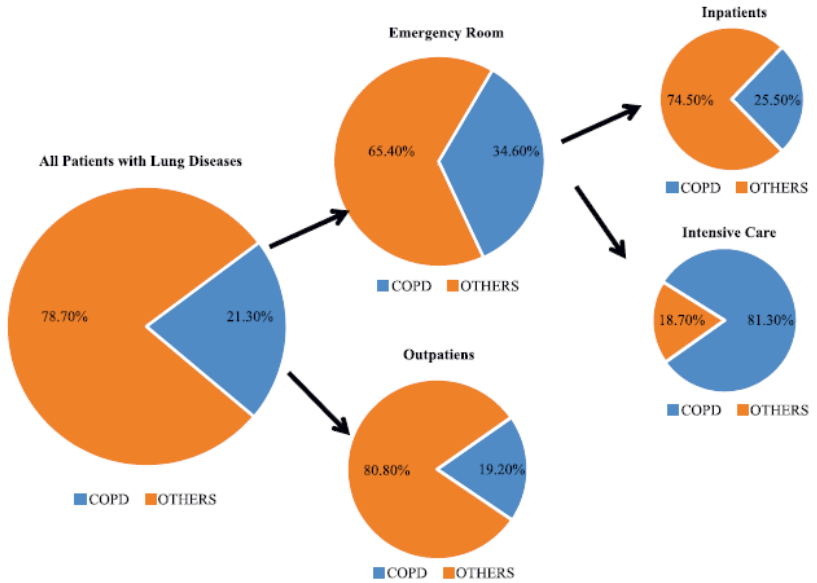

Figure 1*.Distribution of chronic obstructive pulmonary disease patients among overall patients with lung diseases received service in one-year period*

provided were calculated and incurred directly on patients that received this service.

Supportive Service Centers

These are cost centers that have no direct association with patient treatment, which is a primary service of hospitals, but provide services that are obligatory for the execution of these activities. These are expense centers such as social services including kindergarten and dwelling houses, and laundry, tailor shop, and technical service. Since no direct association could be established between the costs of these centers and services, incurring their costs on services could only be possible via allocation keys.

One of the most important goals of cost accounting is to incur the expenses on products in the most accurate way. This requires expenses to be allocated in the most accurate way. Allocation of expenses in the calculation method of expense items is performed in three ways (6) Allocation of expenses to the expense centers (first allocation), II) Allocation of expenses collected in the auxiliary service expense centers to the main service centers (second allocation), and III) Incurring the expenses collected in the main service centers on the products or services produced in that expense centers (third allocation).

In the present study, costs of the main service centers and auxiliary service expense centers were calculated separately. For cost analysis of inpatients, direct allocation was performed for medications, medical consumables, examinations, food, and personnel expenses. For the calculation of personnel expense, number of staffs working in each unit was determined and calculation was performed over personnel expense (such as salary, working fund, and overtime) of relevant unit. Electricity, water, heating, cleaning, maintenance and repair, stationery, depreciation, and hospital management expenses, which are present in the expense cost sheet but cannot be allocated directly, were added to the cost using allocation keys. For the calculation of heating and cleaning expenses, unit price was found dividing annual total relevant expense (TL) by total hospital area (m2). Area of service units was multiplied by unit price and annual heating and cleaning expenses were calculated for each unit. While calculating electricity allocation rate, the area of service units and electric consumption of the devices were considered. Of the communication expenses (phone, internet, mail), 51% was allocated to hospital management expense, 30% was allocated to inpatient service expense, and the remaining 19% was allocated equally to other units. Maintenance and repair expenses of equipments that require advance technology and full-

Table 2. *Distribution of management expenses to service units and total expenses in the units*

Service units	Allocation rate (%)	Management expense*	Collected from the 1st allocation**	Total expense***
Chest Diseases	31	591,552.56	7,415,381.74	8,006,934.30
Thoracic Surgery	9	171,741.07	1,971.961.87	2,143,702.94
Tuberculosis	4	76,329.34	287,305.44	363,634.78
Internal ER	15	286,235.10	1,077,248.09	1,363,483.19
Surgical ER	5	95,411.68	585,426.90	680,838.58
Respiratory ICU	1.75	33,394.09	478,295.79	511,689.88
Surgical ICU	2.75	52,476.42	351,812.83	404,289.25
Polyclinics	12	228,988.08	777,073.87	1,006,061.95
Operating room	4	76,329.34	727,835.54	804,164.88
Other polyclinics	8	152,658.72	953,771.88	1,106,430.60
Chemotherapy	2	38,164.67	163,675.94	201,840.61
Laboratory	1.5	28,623.50	1,346,563.06	1,375,186.56
Tomography-US	0.5	9,541.16	424,636.42	434,177.58
Radiology	0.5	9,541.16	256,154.19	265,695.35
Pathology	0.5	9,541.16	418,005.13	427,546.29
Bronchology	2	38,164.67	589,239.24	627,403.91
Pulmonary function	0.5	9,541.16	80,320.68	89,861.84
Total	100	1,908,233.88	17,904,708.61	19,812,942.49

*ER, Emergency Room; ICU, Intensive Care Unit; US, Ultrasonography, * 2nd Allocation; ** Also present in Table 1; *** Total expense after the 1st and 2nd allocations*

automation system, which are being used in our hospital, as well as of the building, were calculated using expense cost sheet. Stationery expenses were calculated according to the data obtained from hospital supplies. Costs of medical consumables and medications used by each unit were determined according to the data obtained from HIMS. Of the depreciation price, which was calculated according to the institution's expense cost sheet, 30% was allocated to the hospital management expenses. Since the costs of fixtures used in laboratory, imaging centers, and bronchology were higher, 40% of depreciation expense was allocated to these places. Allocation rates for services and intensive care units were determined considering medical devices and fixtures used in these units. Since the hospital building has been rented, the rental of building was also reflected onto the cost.

In our hospital, almost all of food, cleaning, and technical services are being provided by external service procurement. Patients' food expenses were added to the cost of patient at the end of allocation. Employees' food prices were added to the hospital management expense since it is covered by the hospital budget. Since technical service maintenance and repair expenses are invoiced in detail, costs could be directly allocated to the relevant departments. Patient admittance and social services, which are among auxiliary service units, are the services that equally influence the entire hospital. Thus, expenses in auxiliary service units were considered as the hospital management expenses. Sterilization center is run as service procurement and sterilization of operating room and laboratory equipments is performed. This expense was allocated directly to the relevant units.

With these calculations, the proportion and cost burden of COPD in one-year hospital expense was accurately demonstrated. The expenses were represented as average US Dollar exchange rate (1TL=1.523 US Dollars) in the relevant year.

Table 3. **Number of all patients with lung diseases received services a nd number and percentage of patients with chronic obstructive pulmonary disease in one-year**

Service Units	Overall patients (n)	COPD patients (n) (%)
Polyclinic	334.971	64.414 (19.2)
Internal ER	47.655	16.518 (34.6)
Chest Diseases	15.768	4.017 (25.5)
Respiratory ICU	246	200 (81.3)
Total	398.640	85.149 (21.3)

COPD. Chronic obstructive pulmonary disease; ER. Emergency Room; ICU. Intensive Care Unit

RESULTS

Total expenses after the first allocation according to the units in the hospital are demonstrated in Table 1. Hospital management expenses for 2010 was 2.150.691.26 US Dollars. Hospital employees' food expense of 1.081.102.51 US Dollars was paid by the hospital. Moreover, 11.596.58 US Dollars of rental expense paid in 2010 was considered as hospital management expense and then it was planned to be allocated to all units. Total hospital management expense was 3.180.389.80 US Dollars. Proportion of patient services was considered to be 60% among hospital services and 60% of hospital management expenses was calculated to be 1.908.233.88 US Dollars. Of this amount, 20% (381.646.77 US Dollars) was allocated to polyclinics, 20% (381.646.77 US Dollars) was allocated to ambulatory treatment centers, and 60% (1.144.940.33 US Dollars) was allocated to inpatients. Distribution of management expenses to service units is demonstrated in Table 2.

Patients with COPD received services at polyclinics, internal emergency room, chest diseases units, and respiratory intensive care unit. Number of patients received services in these units in one-year period and number and percentage of COPD patients in each of these units are presented in Table 3 and Figure 1. Tomography performed for comorbid conditions, bronchoscopy procedures, or thoracic surgery services given for physical examination were excluded since they were in limited numbers. Services were also provided by laboratory, radiology and pulmonary function units. Costs of these services, number of examinations, and unit cost of examinations were calculated. Cost of examinations was calculated using the number of examinations performed in COPD patients and added to the cost of COPD patients.

In one-year period, 187.024 X-rays were performed and unit cost of a single X-ray was calculated to be 1.42 US Dollars. Number of X-rays (167.024 X-rays in total; 20,000 were performed at surgery unit and intensive care unit) performed in the patients at main service expense centers and the number and cost of X-rays performed in the patients examined with the diagnosis of COPD among these patients are demonstrated in Table 4. In one-year period, 1.470.637 examinations were performed at biochemistry and bacteriology laboratories. Unit cost of examinations was calculated to be 0.932 US Dollars. Number of examinations performed in the patients receiving services at main service expense centers and the number and cost of examinations performed in the patients examined with the diagnosis of COPD among these patients are demonstrated in Table 5. In one-year period, 77.130 pulmonary function tests were performed and unit cost of pulmonary function test was calculated to be 1.17 US dollars. Number of pulmonary function tests performed in the patients received services at main service expense centers and the number and cost of pulmonary function tests performed in the patients examined with the diagnosis of COPD among these patients are presented in Table 6.

According to the data obtained from HIMS, 15.768 patients stayed at internal chest diseases units in one-year period and 4.017 (25.5%) of these were COPD patients. Total number of hospital stay days was 127.593, whereas it was 35.349 for COPD patients. Total expense of chest diseases centers was calculated to be 8.006.934.3 US Dollars. One-day patient cost was calculated dividing this expense by total number of hospital stay days in one-year period. One-day cost of hospital stay was found to be 62.75 US Dollars and one-day food expense per patient was calculated to be 4.07 US Dollars. Adding X-ray expense (6.414.14 US Dollars), laboratory expense (158.251.74 US Dollars), and pulmonary function test expense (4.604.85 US Dollars) for COPD inpatients, the annual cost for 4.017 COPD inpatients was found to be 2.531.290.91 US Dollars (Table 7).

***Table 4**. Distribution of X-ray expenses in chronic obstructive pulmonary disease patients*

Service Units	Total X-ray examinations n	X-ray examination for COPD patients n (%)	Cost of X-ray examination for COPD patients (US dollars)
Chest Diseases	42.304	4.517 (10.68)	6.414.14
Internal ER	42.655	16.518 (38.7)	23.455.56
Polyclinics	53.835	17.440 (32.4)	24.764.80
Respiratory ICU	1.230	996 (80.9)	1.414.32
Total	167.024	39.471 (23.6)	56.048.82

COPD, Chronic obstructive pulmonary disease; ER, emergency room; ICU, Intensive care unit

In one-year period, 47.655 patients were treated in internal emergency room and 16.518 (34.6%) of them were treated for COPD. One-year total expense of internal emergency room was calculated to be 1.363.483.19 US Dollars. Of this expense, COPD patients accounted for 471.765.18 US Dollars. Of the COPD patients treated in emergency room, X-ray expense was 23.455.56 US Dollars and laboratory expense was 90.950.15 US Dollars. Pulmonary function test was not performed in emergency room. Based on these data, one-year cost of COPD patients treated in internal emergency room was calculated to be 586.170.73 US Dollars.

In one-year period, 334.971 patients were admitted to the polyclinic and 64.414 (19.2%) of these patients had COPD. Total annual cost of polyclinic was 1.006.061.95 US Dollars, of which 193.163.89 US Dollars were for COPD patients. The cost for COPD patients receiving polyclinic service was calculated to be 24.764.8 US Dollars for X-ray, 53.973.98 US Dollars for laboratory, and 31.141.9 US Dollars for pulmonary function test. One-year polyclinic cost of COPD patients was calculated to be 303.044.57 US Dollars.

In one-year period, 246 patients were treated at respiratory intensive care unit and 200 (81.3%) of them were COPD patients. One-year cost of respiratory intensive care unit was 511.689.88 US Dollars, of which 416.003.89 US Dollars were the expenses of COPD patients. Moreover, X-ray and laboratory examination expenses of COPD patients treated at this unit were 1.414.32 US Dollars and 1.864.0 US Dollars, respectively; pulmonary function test was not performed for the patients treated at this unit. One-year cost of COPD patients treated at respiratory intensive care unit was calculated to be 419.282.21 US Dollars.

Annual cost according to the activity-based costing system was found to be 3.839.788.32 US Dollars for COPD patients examined and treated as inpatient, or at emergency room, or at respiratory intensive care unit, or at polyclinics of Yedikule Chest Diseases and Thoracic Surgery Training and Research Hospital (Table 8 and Figure 2).

***Table 5**. Distribution of laboratory examination costs in chronic obstructive pulmonary disease patients*

Service Units	Total examinations n	Examinations for COPD patients n (%)	Cost of Examinations for COPD patients (US Dollars)
Chest Diseases	638,342	169,798 (26.6)	158,251.74
Internal ER	282,040	97,586 (34.6)	90,950.15
Polyclinics	301,630	57,912 (19.2)	53,973.98
Respiratory ICU	2,460	2,000 (81.3)	1,864.4
Total	1,224,472	327,296 (33.9)	305,039.87

Table 6. Distribution of the cost of pulmonary function tests among chronic obstructive pulmonary disease patients

Service Units	Total PFT examination n	Examination for COPD patients n (%)	Cost of examination for COPD patients (US Dollars)
Chest Diseases	6.587	3.940 (59.8)	4.609.8
Internal ER	0	0	0
Polyclinics	66.543	26.617 (40.0)	31.141.9
Respiratory ICU	0	0	0
Total	73.130	30.557 (41.8)	32.751.7

DISCUSSION

The present study demonstrated one-year activity-based costing of main services provided at a training and research hospital at admission to polyclinics and emergency room and during hospital and intensive care unit stay, of auxiliary services at laboratory and imaging centers, and of social and technical support services that are mandatory while carrying out all of these activities and indicated proportion of COPD in this costing. It was determined that COPD patients accounted for 21% of overall patients and cost of COPD patients accounted for 19% of overall cost. The activity-based costing system used in the present study has been developed as an alternative approach to some problems encountered in traditional costing methods and is a costing method increasingly becoming widespread. Activity-based costing system has been a preferred method also in hospitals within the scope of planning better service as is in many service sectors such as hotels, postal services, transportation, finance, logistic, libraries, and workshops (7). Studies revealing disease-related economic burden on population are called as cost of illness and costing studies are necessary for health services to be provided more productively and effectively (8). The importance of hospitals, which are a kind of enterprise and service center, has rapidly increased in line with the advances in medical field and hospitals have become the most important sub-systems of health system in terms of service production capacity and health expenditures. With regard to the distribution of expenditures of the Republic of Turkey Ministry of Health budget, hospital expenditures ranked first with 51.1% in 1992 and with 59.4% in 2005 (9).

A hospital should deal with costing even without profit making purpose. Hospital administrations are supposed to provide the most qualitative service with the least price. Increase in hospital cost day by day and necessity of managing this increasing cost enhance the need for cost accounting. Thereby, determination of productivity and efficacy of the given service could be provided. Cost accounting is a tool that provides effective and reliable information to the administrators on process costing, controlling expenses, planning the future, and making decision on vital issues. Cost accounting is used to make decision on budgeting, evaluating difference between standard and actual costs, profitability, pricing policy, assumption of future costs, extending or collapsing provided services, and making decision whether to collapse external service procurement or to produce service within the enterprise (10).

In the present study, costs of patients who stayed at our hospital in 2010 for COPD, or received service at emergency room, or underwent examination and treated at polyclinics or respiratory intensive care unit when necessary were calculated. One-year cost of COPD patients was calculated to be 3,839,788.3 US Dollars and it accounted for 19.5% of one-year hospital cost (total annual hospital cost was 20,055,400.8 US Dollars). In another study conducted in Turkey, among the diagnoses, COPD was demonstrated to account for the highest cost in overall cost of patients stayed at chest diseases clinic (11).

In a study from Germany, in which the economic burden of smoking-associated diseases was investigated, it was determined that smoking-associated diseases caused totally 16.6 billion Euros health expenditure, of which 51.1% was direct health expenditure Emergency hospitalization due

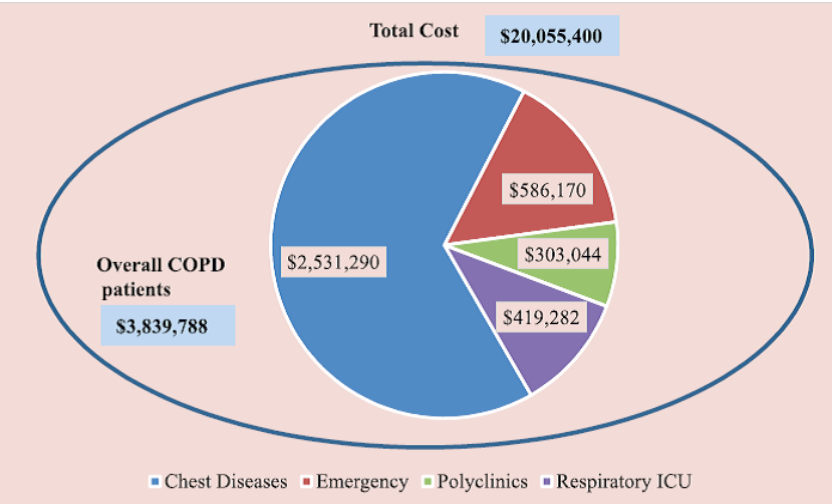

Figure 2. *Schematized illustration of costs of overall patients, overall chronic obstructive pulmonary disease patients, and distribution of cost for chronic obstructive pulmonary disease patients receiving services among the units.*

to these diseases accounted for 27% of direct health expenditures. In that study, it was demonstrated that COPD alone caused 5.5 billion Euros health expenditure (12).

Assuming that total cost of COPD, which is the third leading cause of death in the USA, was 50 billion Dollars (20 billion Dollars indirect costs, 30 billion Dollars direct health care expenditures) and there were 12 million COPD patients in 2010, it was reported that annual cost per patient exceeded 4000 dollars (13). A study conducted in USA evaluated 37.089 COPD patients; polyclinic cohort accounted for 53%, emergency room cohort accounted for 37%, emergency service cohort accounted for 3%, and standard hospitalization and intensive care unit hospitalization cohorts accounted for 6% of the patients (14). It was determined that the annual COPD-associated cost per patient ranged from 2.003±3.238 US Dollars to 43.461±76.159 US Dollars in the cohorts. Medical costs accounted for 96% of health care expenses in the intensive care unit group. The adjusted average cost per attack was 305±310 US Dollars for polyclinic, 274±336 US Dollars for emergency room, 327±65 US Dollars for emergency service, 9.745±2.968 US Dollars for a standard hospitalization, and 33.440 US Dollars for intensive care unit (14). In a study from Canada, in which moderate and severe COPD patients were evaluated, the average annual COPD-related cost per patient was calculated to be 4.147 dollars (15). It was reported that cost per patient for maintenance was 2.475 dollars (71% was for medication), whereas cost per patient for the treatment of acute exacerbations was 1.673 dollars (82% was for hospitalization). In a cohort study comprising 58.589 patients from United Kingdom, the average total annual cost per patient for COPD was calculated to be 2.108 Pounds excluding medications (16).

Table 7. *One-year cost of chronic obstructive pulmonary disease inpatients*

Number of COPD inpatients	*4.017*
Total number of hospital stay days	*35.349*
Total cost of patients (US Dollars)	*2.218.149.75*
Total cost of food (US Dollars)	*143.870.43*
Cost of X-ray (US Dollars)	*6.414.14*
Laboratory cost (US Dollars)	*158.251.74*
Cost of PFT (US Dollars)	*4.694.85*
Total annual cost (US Dollars)	*2.531.290.91*

Table 8. *Chronic obstructive pulmonary disease patients' cost per capita and total annual costs*

	n	*Cost per capita (US Dollars)*	*Total cost (US Dollars)*
Chest Diseases	*4.017*	*630.14*	*2.531.290.91*
Internal ER	*16.518*	*35.48*	*586.170.73*
Polyclinics	*64.414*	*4.70*	*303.044.57*
Respiratory ICU	*200*	*2.096.41*	*419.282.11*
Total			*3.839.788.32*

It has been reported that cost increases as the grade of COPD increases. Cost per patient for severe exacerbations and hospital stay are higher as compared to primary care (15). In two different studies from Turkey, the cost per patient for COPD patients hospitalized due to acute exacerbation was calculated to be 1.765±2.139 US Dollars (17) and 718±364 US Dollars (18). Total medical cost of high-grade COPD patients was found approximately three times higher than that of low-grade patients (annual cost, 3.744 Dollars vs. 1.183 Dollars per patient) (19). In Denmark, a study evaluating direct and indirect medical costs of COPD patients in a 12-year period demonstrated that the rates of health-related contacts and drug use and socioeconomic costs were higher in the COPD patients compared to the control group (20).

In the BREATHE study comprising Middle-Eastern and North African countries (Algeria, Egypt, Jordan, Lebanon, Morocco, Saudi Arabia, Syria, Tunisia, Turkey, and United Arab Emirates) and Pakistan, 62.086 individuals were screened using standard methodology in general population sampling and 2.187 individuals were found to fulfill COPD criteria. Of these, 1.392 individuals who completed the survey formed the study group (21). BREATHE study determined that only one fifth of the patients were hospitalized or admitted to emergency room due to COPD in the last year. In addition, it was observed that half of the patients were still on medication. As the result, it was concluded that the disease was under-diagnosed in the region and that treatment was inadequate (Idrees et al., 2012). This suggests that costs would be higher than calculated when diagnosis and treatment of patients are performed sufficiently. While the most important intervention in preventing COPD is quitting smoking, two-third of the individuals (64.5%; ranging from 48.5% in Algeria to 82.4% in the United Arab Emirates) in the BREATHE study were current smokers and two-third of them had never tried quitting (66.1%; ranging from 48.9% in Jordan to 86.7% in Algeria). Nearly one-third (31.4%) of the individuals reported that their physicians had never recommended to quit smoking (22).

In the present study, cost of COPD was calculated only based on admission to the hospital. Indirect costs such as companion and transportation expenses and economic burden such as labor loss and smoking were not included. Besides, considering that there are patients in the population that cannot receive hospital services, as well as patients admitting to private health care centers, it can be expected that the economic burden of COPD would be higher.

Key messages: Each unit's cost can be computed by activity-based costing in nonprofit hospitals. Activity-based costing can clearly show economic burden of a disease on hospitals. COPD has the highest cost among all chest diseases. Economic burden of COPD is associated with acute exacerbations. Quitting smoking before having COPD is appropriate for everyone.

In conclusion, COPD is a high-cost disease with high economic burden. In order to decrease the frequency of diseases for which smoking is the primary risk factor such as COPD and thereby to minimize the cost of illness, campaigns against smoking should be supported, smokers should be encouraged to quit smoking, and exposure to cigarette smoke (second-hand smoking) should be prevented. Moreover, and follow-up of COPD patients with appropriate treatment would contribute to the decrease in total cost by decreasing acute exacerbations and hospital stay.

Competing interests

We wish to confirm that there are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome.

Authors' contributions

The study was conceived, analyzed and written by MGO. AB and SA was responsible for the data management and analysis.HNU participated in the critical review of the manuscript.FK participated in the critical review of the paper and offered suggestion that help shaped the paper. AC supported in the study design and overall critical review of the paper.We confirm that the manuscript has been read and approved by all named authors.

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