

Costs of Chronic Obstructive Pulmonary Disease in Spain: Estimation From a Population-Based Study

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OBJECTIVE: In the studies carried out to date, the cost of chronic obstructive pulmonary disease (COPD) may have been overestimated due to the inclusion of previously diagnosed patients seeking medical attention for their symptoms. As a result, the severity of the cases included in these studies may have been greater than in an unselected sample of the general population. The aim of the present study was to estimate the direct cost of COPD on the basis of a representative sample of the overall Spanish population between 40 and 69 years of age (from the IBERPOC study).

METHOD: The cost was evaluated retrospectively by means of a questionnaire completed by the 363 patients with COPD from the IBERPOC study with questions referring to the previous year. Standardized spirometry was performed on all the patients by a pneumologist in each of the 7 geographical areas in which the study was carried out.

RESULTS: Hospitalization accounted for the greatest expenditure (41% of total), followed by drug therapy (37%). The cost was €98.39 per patient, and €909.50 per previously diagnosed patient. The cost per person of severe COPD was more than 3 times that of moderate COPD and more than 7 times that of mild COPD. The estimated annual cost of COPD in Spain was €238.82 million (for 1997).

CONCLUSION: The present study, which was the first to estimate the cost of COPD in a representative sample of the general population, found the cost to be lower than in studies analyzing samples of patients with previous diagnoses of COPD. The cost distribution is not in line with recommended health care practices, underlining the need to optimize resources used to monitor and treat the disease, with an emphasis on early diagnosis.

Key words: COPD. Costs. Pharmacoeconomics. Treatment. Diagnosis. Epidemiology.

The IBERPOC study is an initiative of the Assembly on Respiratory Insufficiency and Sleep Disorders (IRTS) of the Spanish Society of Pneumology and Thoracic Surgery (SEPAR).

Funding was obtained from Boehringer Ingelheim Spain, S.A.

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Manuscript received March 4, 2003. Accepted for publication October 7, 2003.

Costes de la EPOC en España. Estimación a partir de un estudio epidemiológico poblacional

OBJETIVO: En los estudios realizados hasta ahora, el coste de la enfermedad pulmonar obstructiva crónica (EPOC) puede estar sobrestimado porque han incluido a pacientes previamente diagnosticados que consultaron por sus síntomas, por lo que la gravedad puede ser superior a la que realmente tendría una población no seleccionada obtenida de la población general. El propósito del presente estudio fue estimar el coste directo de la EPOC basándose en una muestra representativa del conjunto de la población española de entre 40 y 69 años (estudio IBERPOC).

MÉTODO: El coste se evaluó retrospectivamente a través de un cuestionario referido al último año en los 363 pacientes con EPOC del estudio IBERPOC. Un neumólogo realizó a todos ellos una espirometría estandarizada en cada una de las 7 áreas geográficas en las que se llevó a cabo el estudio.

RESULTADOS: La asistencia hospitalaria fue el coste más elevado (41% del coste total), seguido del tratamiento farmacológico (37%). El coste por paciente fue de 98,39 €, y por paciente previamente diagnosticado, de 909,5 €. El coste de la EPOC grave por persona fue más de tres veces el coste de la EPOC moderada y más de 7 veces el coste de la EPOC leve. El coste anual estimado de la EPOC en España fue de 238,82 millones de euros (información referida a 1997).

CONCLUSIÓN: Éste es el primer estudio que estima el coste de la EPOC en una muestra representativa de la población general, que es inferior al calculado por los estudios que han analizado una muestra seleccionada con diagnóstico previo de EPOC. La distribución del gasto no se ajusta a las prácticas asistenciales recomendables, por lo que son necesarias actuaciones que optimicen los recursos empleados en el seguimiento y en el tratamiento de la enfermedad, prestando especial atención a su diagnóstico temprano.

Palabras clave: EPOC. Costes. Farmacoeconomía. Tratamiento. Diagnóstico. Epidemiología.

Introduction

Chronic obstructive pulmonary disease (COPD) affects more than 52 million people throughout the world and caused more than 2.74 million deaths in the year 2000.^{1,2} It is the fourth cause of death in developed countries,¹⁻⁴

preceded only by cancer and cardiovascular and cerebrovascular disease. It is the only disease on the rise, for which reason it may become the third cause of death in coming years. As COPD accounts for 10% of patient visits to a pneumologist, 7% of all hospital admissions, and 35% of permanent work disability, the health, social, and economic impact of the disease is high.

Various studies done in Spain,⁵⁻⁸ the rest of Europe,⁹⁻¹² and North America¹³⁻¹⁸ have tried to estimate the overall cost of the disease. The results have revealed variation, possibly due in part to differences in costs between countries and in the methods used. In many of these studies costs may have been overestimated because of the inclusion of previously diagnosed patients seeking medical attention for their chronic symptoms or for exacerbations. Consequently, severity of disease in these studies might have been greater than in a random sample of the general population.

The IBERPOC study,¹⁹ a population-based epidemiological survey, found a 9% prevalence of COPD in Spain in individuals between the ages of 40 and 69 years. An estimation of the consumption of health care resources (direct costs) for COPD based on the IBERPOC study would have the advantage of providing a calculation for an unselected general population. Furthermore, diagnosis was confirmed by spirometry under standardized conditions. Spirometry was performed by only 7 pneumologists (1 for each geographic area) who had previously participated in a study of inter-rater agreement.²⁰ No other study published with a view to assessing the cost of COPD has used a similar population or has applied criteria to control the quality of spirometry. From these data, we have tried to estimate the direct health care costs of COPD in Spain, based on a representative sample of the overall Spanish population between the ages of 40 and 69 years.

Method

The method followed in the IBERPOC study has been previously published.^{19,21} Briefly, it was a population-based epidemiological study carried out in 7 geographic areas of Spain representing different climates and including both urban and rural populations. There was a target population of 236 412 people, included in the official census, residing in the areas studied. A random selection of 5014 individuals (2592 women and 2512 men between the ages of 40 and 69 years) was carried out.

The fieldwork was done between October 1996 and April 1997 by 7 trained pneumologists,²¹ each of whom contacted the participants, conducted the interviews, and performed the spirometry in one of the 7 areas. In the end, the study was completed for a total of 4035 individuals. Of those interviewed, 363 were diagnosed with COPD according to the criteria detailed below (prevalence of COPD, 9.1%). These individuals comprised the population of the present study.

Spirometry

All spirometry was performed with the same type of spirometer (Datospir 200, Sibel S.A., Barcelona, Spain) and

according to American Thoracic Society²² guidelines. The spirometric reference values of Roca et al²³ were used to calculate percentages of predicted values. A bronchodilator test was performed on subjects who had a ratio of forced expiratory volume in 1 second (FEV₁)/forced vital capacity (FVC) under 88% of predicted in men and under 89% in women. A relative increase in FEV₁ or FVC of more than 12% and an absolute increase of more than 200 mL (in FEV₁ or FVC) were considered a positive response.

Diagnostic Criteria for COPD

Patients with a previous diagnosis of asthma (according to the European Coal and Steel Community questionnaire²⁴) were excluded. In order to determine the existence of bronchial obstruction, the criteria of the European Respiratory Society²⁵ (FEV₁/FVC < 88% of predicted in men and < 89% in women) were followed. Subjects in whom bronchial obstruction disappeared after the bronchodilator test were excluded in accordance with European Respiratory Society criteria. In the few cases in which the bronchodilator test could not be performed, subjects with a FEV₁/FVC ratio more than 81% of predicted in absolute value and a FEV₁ more than 70% of predicted were excluded. The same European Respiratory Society criteria were followed to establish the severity of COPD²⁵ (mild: FEV₁ ≥ 70% of predicted; moderate: FEV₁ 50%-69% of predicted; severe: FEV₁ < 50% of predicted).

Cost Analysis

In the IBERPOC questionnaire data on drug therapy, home oxygen therapy, ambulatory visits, emergency department visits, and hospitalizations in the general ward or intensive care unit (ICU) during the previous year were gathered retrospectively. Information on laboratory and diagnostic tests and other procedures performed in the year prior to the interview (during a stable phase or exacerbation) was also collected.

The data gathered on patients' usual drug therapy were assumed to be the same for the rest of the year. For treatment of exacerbations, patients were asked about the treatment given for their last exacerbation in an ambulatory setting. The distribution of percentages calculated for cases with complete data were applied to cases in which data were missing. Patient tolerance of treatment was assumed to last 10 days. The pharmacological information recorded on the questionnaire was based on active principles, which were then translated into the product most widely used on the market. For cost estimations, official prices for 1997 were used.²⁶

The cost of home oxygen therapy, ambulatory visits, emergency department visits, hospitalization in the general ward and in ICU's, and laboratory and diagnostic tests was estimated using the SOIKOS²⁷ health care cost database. In 1997 this database was composed of entries from more than 280 published sources. To obtain the unit cost per resource, we first determined the different costs of each one, then updated them to 1997 prices using the consumer price index, and finally calculated the arithmetic means (Table 1). For the calculation of ambulatory visit costs, all visits were considered to be to primary care physicians. For hospital stays in the general ward, care by the respiratory medicine service was assumed, with a mean stay of 8 days, in accordance with published data.^{28,29} The cost of hospitalization included hospital stay, diagnostic tests, and treatment. Such specific costs as noninvasive mechanical ventilation, surgical

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TABLE 1
Unit Costs of Resources*

Resource	Cost (Euros, 1997)
Ambulatory visit	6.34
Hospital stay (pneumology service)	279.09
ICU stay	974.25
Hospital emergency department	87.18
Chest x-ray	14.94
Blood test	13.64
Theophylline concentration	13.63
Electrocardiogram	17.10
Arterial blood gases	20.69
Spirometry	30.85
Oxygen therapy, day	3.61

*ICU indicates intensive care unit.

treatment, respiratory rehabilitation, and so on were not included.

The overall cost for the sample was estimated by adding the cost of each of the components assessed. The per patient cost was calculated by dividing the overall cost for the sample

by the number of patients diagnosed with COPD in the IBERPOC study and by the subgroup of patients who had been previously diagnosed with COPD, and were therefore those who had generated the expenditure. Finally the overall cost of COPD in Spain was estimated by multiplying the cost per patient diagnosed with COPD in the IBERPOC study by the number of patients extrapolated from the prevalence of the disease found in the same study¹⁹ for a population between the ages of 40 and 69 years.

Results

The characteristics of the 363 subjects diagnosed with COPD are shown in Table 2. The patients with the most severe disease were older and more often men than those with the mildest. Forty-two percent were active smokers, and the most severe group smoked more and had more exacerbations. The mean (SD) FEV₁ of the 363 subjects with COPD was 69.66% (18.2%) of predicted value.

TABLE 2
Characteristics of Patients Diagnosed With Chronic Obstructive Pulmonary Disease in Function of Severity*

	Mild (n=139; 38%)	Moderate (n=144; 40%)	Severe (n=80; 22%)	Total (n=363)
Male sex	80 (57.6%)	128 (88.9%)	74 (93.7%)	282 (77.9%)
Age, years	54.7 (SD 8.80)	58.17 (SD 7.78)	63.16 (SD 5.68)	57.90 (SD 8.40)
BMI	26.48 (SD 4.09)	27.08 (SD 4.49)	26.69 (SD 4.13)	26.76 (SD 4.26)
Active smokers	50 (36%)	71 (49.3%)	31 (39.2%)	152 (42%)
Pack-years	35.21 (SD 21.28)	49.91 (SD 27.11)	62.27 (SD 34.32)	47.53 (SD 28.55)
Exacerbations/person/year	0.42 (SD 0.73)	0.53 (SD 1.56)	0.67 (SD 0.93)	0.52 (SD 1.16)
FVC, % of predicted	114.31 (SD 13.00)	91.75 (SD 11.54)	68.00 (SD 12.76)	95.23 (SD 21.44)
FEV ₁ , % of predicted	87.39 (SD 9.57)	66.62 (SD 6.09)	43.99 (SD 8.11)	69.66 (SD 18.24)
FEV ₁ /FVC%	83.52 (SD 4.12)	78.67 (SD 7.06)	70.21 (SD 10.51)	78.69 (SD 8.64)

*BMI indicates body mass index; FVC, forced vital capacity; FEV₁, forced expiratory volume in 1 second.

TABLE 3
Cost of Ambulatory Care Treatment During the Last Year*

	Euros	PUDT	PUT	PTUE
Usual drug therapy				
Theophyllines	1322	7.8	6.7	4.6
Oral β 2-adrenergic agonists	853	5	4.3	2.9
Inhaled β 2-adrenergic agonists	799	4.7	4.1	2.8
LA inhaled β 2-adrenergic agonists	5133	30.2	26.1	17.7
Ipratropium bromide	355	2.1	1.8	1.2
Inhaled corticosteroids	7705	45.3	39.2	26.6
Oral corticosteroids	150	0.9	0.8	0.5
Mucolytics	703	4.1	3.6	2.4
Gastric protective agents				
Total for usual drug therapy	17 020	100	86.7	58.8
Oxygen therapy	2632		13.4	9.1
Total for usual treatment	19 652			67.9
Drug therapy for exacerbations [†]		PDTE	PUT	PTUE
Antibiotics	4784	51.5		16.5
Inhaled corticosteroids	3714	39.9		12.8
Bronchodilators	355	3.8		1.2
Oral corticosteroids	445	4.9		1.5
Total for drug therapy for exacerbations	9298	100		32.1
Total for treatment	28 950			

*PUDT indicates percentage of total associated with usual drug therapy; PDTE, percentage of total associated with drug therapy for exacerbations; PUT, percentage of total associated with usual treatment; PTUE, percentage of total associated with usual treatment and treatment of exacerbations.

[†]Number of exacerbations: 171.

TABLE 4
Resources and Costs for the 363 Cases of Chronic
Obstructive Pulmonary Disease in the Last Year*

Resource	Units	Euros	PHC/PAC	PTC
Hospital care				
Stays	93	25 837	87.6	60.1
ICU	1	1106	3.7	2.6
Emergency Department [†]	29	2542	8.6	5.9
Total for hospital care		29 485	100	68.6
Ambulatory care				
Ambulatory visits	172	1088	8.1	2.5
Chest x-rays	147	2200	16.3	5.1
Spirometry	60	1839	13.6	4.2
Blood tests	304	4147	30.7	9.6
Theophylline concentration	81	1100	8.2	2.6
Electrocardiograms	150	2560	19	6
Arterial blood gases	28	571	4.2	1.3
Total for ambulatory care		13 505	100	31.3
Total for health care services		42 990		

*PHC/PAC indicates percentage of total associated with hospital care and percentage of total associated with ambulatory care; PTC, percentage of total associated with total health care services (hospital and primary care); ICU, intensive care unit.

[†]Hospital emergency department visits without admission.

The cost of usual drug therapy and home oxygen therapy during the previous year can be seen in Table 3. The cost of usual drug therapy was almost 7 times greater than that of oxygen therapy. Inhaled corticosteroids accounted for the greatest percentage of drug therapy expenditure (26.6%), followed by long-acting β_2 -adrenergic agonists (17.7%). The cost associated with the use of ipratropium bromide (1.2% of the total) was almost 4 times less than that of theophyllines, 2 times less than that of mucolytics, and almost 22 times less than that of inhaled corticosteroids.

Table 3 also shows the cost of treating exacerbations in an ambulatory setting. The use of antibiotics represented the highest percentage of the cost (51.5%), followed by inhaled corticosteroids (39.9%). The cost associated with the use of bronchodilators was much lower than the two mentioned above (3.8%). Of the total cost of drug therapy for COPD, drugs given as usual medication accounted for 58.8%, and those used for treatment of exacerbations, 32.1%; the rest was due to oxygen therapy.

Table 4 presents the cost of ambulatory and hospital care. The cost of hospital care was twice that of ambulatory care. The cost derived from hospital stays represented 60% of total health care service costs, while ambulatory care accounted for only 31.3%. Blood tests accounted for the highest percentage of ambulatory care cost, followed by electrocardiograms. The cost arising from spirometry was much lower than the costs for blood tests, electrocardiograms, or chest x-rays.

Table 5 shows the total and subtotals of the costs for the population studied. The total health care cost for the cohort studied was €71 953. Hospital care represented 41% of the total, followed by usual drug therapy (23.7%), and ambulatory care (18.8%). The mean cost per patient with COPD was €198.17 a year (Table 5). As only 79 patients (22%) with COPD had been previously diagnosed and consequently consumed health care resources, the cost per patient previously diagnosed with COPD was €910.57 a year (Table 5).

The cost per person of severe COPD (previously diagnosed or not) was €413.52 (Table 6). This represents 3.6 times the cost of moderate COPD (€115), and more than 7 times the cost of mild COPD (€55.67). However, as the number of subjects with moderate

TABLE 5
Annual Cost of the 363 Cases and Cost per Diagnosed Patient

	Annual Cost (€)	Cost per Patient (€)*	Cost per Previously Diagnosed Patient (€) [†]	Percent
Usual drug therapy	17 020	46.89	215.45	23.7
Drug therapy for exacerbations	9 298	25.61	117.69	12.9
Oxygen therapy	2 632	7.25	33.32	3.7
Ambulatory care	13 499	37.19	170.87	18.8
Hospital care	29 486	81.23	373.24	41.0
Total	71 935	198.17	910.57	100

*Cost for each of the 363 diagnosed patients; [†]cost for each of the 79 patients who had been previously diagnosed with chronic obstructive pulmonary disease and consequently consumed resources.

TABLE 6
Cost per Patient and Year According to Severity of Chronic Obstructive Pulmonary Disease*

	Mild	Moderate	Severe
Usual treatment	16.33 (29)	18.81 (16)	158.60 (38)
Treatment of exacerbation	19.39 (35)	24.79 (22)	31.54 (8)
Oxygen therapy	0	0	34.19 (8)
Ambulatory care	16.78 (30)	36.34 (32)	65.22 (16)
Hospital care	3.16 (6)	35.04 (31)	123.97 (30)
Total per person	55.67	114.98	413.52
Total per severity [†]	7877.13	16 557.12	33 081.16

*Data are indicated as cost in euros with percentage in parentheses.

[†]Total per person multiplied by the number of subjects in each of the severity groups.

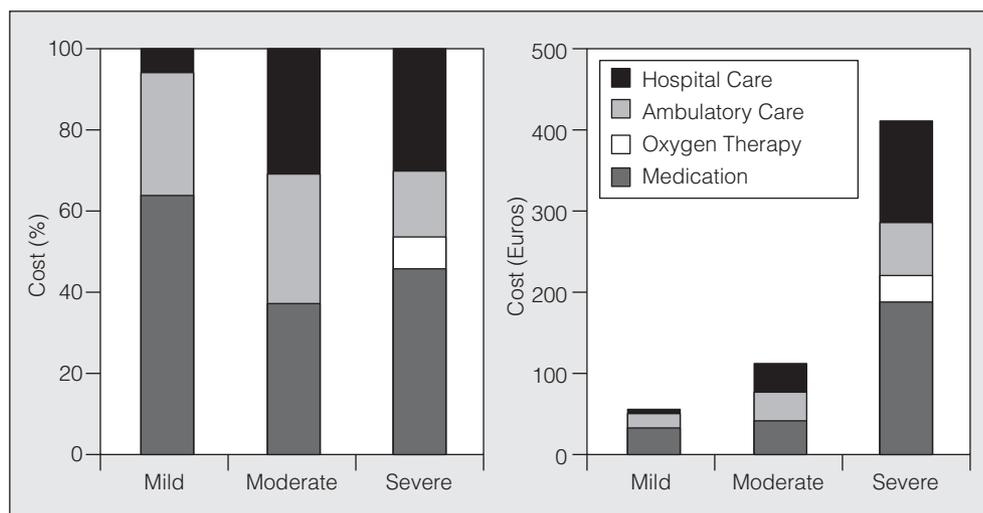


Figure. Distribution of cost per person according to severity of chronic obstructive pulmonary disease. On the left cost distribution is expressed as a percentage, and on the right as an absolute value.

TABLE 7
Studies Estimating the Overall Cost of Chronic Obstructive Pulmonary Disease

Reference	Country	Approach*	FEV ₁ (%)	Cost/Patient	Cost/Year (Millions)
Morera ⁵ (1992)	Spain	Top down	—	€959	€319
Grassi et al ¹⁵ (1992)	U.S.	Top down	—	\$8482	—
Bernard Krief ⁶ (1995)	Spain	Top down	—	—	€260
National Health ¹⁴ (1996)	United Kingdom	Top down	—	\$1900	\$1393
Present study (1997 costs)	Spain	Bottom up	70±18	€198/911 [†]	€239
	U.S.	Bottom up	I: 62±2.8 [‡] II: 44±6.7 [‡] III: 30±3.7 [‡]	\$1681 [‡] \$5037 [‡] \$10 812 [‡]	—
Miravittles et al ⁷ (2000)	Spain	Bottom up	56±16	\$1760	\$506
Jacobson et al ⁹ (2000) (1991 costs)	Sweden	Top down	—	—	\$179
Wilson et al ¹⁸ (2000)	U.S.	Top down	—	\$1341 (emphysema); €816 (chronic bronchitis)	\$14 500
Rutten et al ¹⁰ (1999) (1993 costs)	Netherlands	Top down	—	\$813	\$256
Strassels ³⁵ (2001) (1987 costs)	U.S.	Top down	—	\$6469	—
Dal Negro et al ¹¹ (2001)(2000 costs)	Italy	Bottom up	—	I: €151 [‡]	—
				II: €3001 [‡]	—
				III: €3912 [‡]	—
Jansson et al ¹² (2002) (1999 costs)	Sweden	Bottom up	62	\$603	\$412

*The top-down approach starts from the total figures for all the diseases of a population and by a breakdown process arrives at the specific disease (COPD). The bottom-up approach studies the utilization of resources during a given period of time for a set of subjects with the disease. The total cost is calculated according to prevalence or incidence.

[†]Cost per patient with COPD/cost per patient with previously diagnosed COPD.

[‡]Severe stages according to American Thoracic Society²¹classification.

COPD (144) was far greater than that of patients with severe COPD (80), the total cost for this last group was only twice that of the group with moderate COPD. In severe COPD, usual drug therapy and hospital care accounted for the greatest proportion of the costs, with no significant difference between them. These costs were, respectively, more than double and almost double those associated with ambulatory care. Costs associated with usual drug therapy and hospital care were dramatically lower for subjects with moderate and mild COPD, and did not represent the main expense in these cases (Table 6). In moderate COPD, ambulatory care accounted for the main expense per diagnosed subject, and in mild COPD, drug therapy for exacerbations. If we look at the overall cost of drug therapy (usual and for exacerbation), we find it to be the main component at all 3 levels of severity (Figure).

When we estimated the cost of COPD in Spain based on the 9% prevalence found in the IBERPOC study,²⁰ we obtained the figure of €238.82 million per year in direct health care costs alone.

Discussion

Our study is the first to use a bottom-up design* to assess the overall direct costs of COPD for a representative sample of the general population between the ages of 40 and 69 years. The strength of the present study compared to other bottom-up studies is that it looks at the real population cost and not the

*Cost is calculated by taking a group of subjects with the disease under study as the base population and examining their consumption of resources during a certain period. Subsequently, the overall cost is calculated based on the prevalence or incidence of the disease.

TABLE 8
Overall Cost of Chronic Obstructive Pulmonary Disease in Spain in 3 Studies

	IBERPOC (1997) (Euros, Millions)	Miravittles et al ⁷ (2000) (US Dollars, Millions)	Bernard Krief ⁶ (1994) (Euros, Millions)
Drug therapy+oxygen therapy	96.11 (40%)	206.28 (41%)	122.25 (41%)
Ambulatory care	44.81 (19%)	78.30 (15%)	61.99 (21%)
Hospital care	97.89 (41%)	221.67 (44%)	105.01 (36%)
Total	238.82	506.52	289.19

cost of a clinical practice group in which the disease was diagnosed because patients sought medical attention for their symptoms.^{7,8,11,12,17}

Table 7 presents a comparison between the costs found in our study and those of other published studies. There is considerable disparity among them, possibly because of the use of different years for evaluating costs, differences in health care costs between countries, and the use of different methods of calculation. Focusing on bottom-up approaches, we find the cost per person diagnosed in other studies to be higher than in ours. The percentage of predicted FEV₁ in our study was higher than the one in studies with the same bottom-up approach for which this information is available.^{7,12,17} That observation indicates that severity, and therefore probably cost as well, was lower in our population. Consistent with this, the estimated cost for patients previously diagnosed (€911) came closer to that of other studies carried out on selected patients (Table 7).

If we compare the cost obtained from our study with that of other studies also done in Spain (Table 8), we observe that ours gave the lowest estimate of health care service costs while that of Miravittles et al,⁷ carried out with the same bottom-up approach and using the same database²⁷ to estimate health care service costs, gave the highest. The present study and that undertaken by the Bernard Krief service,⁶ using a top-down approach, revealed similar overall estimated costs.[†] However, the percentage for each component analyzed is similar in all the studies. The difference in the total cost must therefore be attributable either to overestimation in the study of Miravittles et al,⁷ or to underestimation in the present study or in Bernard Krief's.⁶ In the present study, resource consumption was established by asking patients about the previous year. Some details may not have been remembered, and this could no doubt have led to underestimation of costs. Although we cannot rule out the effect of such a limitation, it would seem logical that it would not apply to the same extent to hospital care and drug therapy as to ambulatory care. For example, patients would easily remember if they had been hospitalized or visited an emergency department in the last year, and present drug therapy is likely to be little different from that of the

previous year. Patients may not, however, remember precisely what tests they had had in the last year.

Nevertheless, the proportions each of the 3 components contributes to the total cost are similar in the 3 studies. In the study of Miravittles et al,⁷ patients were followed up for a year, and the record of resource consumption may therefore have been more precise. However, it included a selected group of previously diagnosed patients, and severity of the disease (determined by measuring FEV₁) was considerably greater than in the present study (mean [SD] FEV₁: 56 [18]% of predicted). The differences between the total cost in our study, similar to that obtained by Bernard Krief³⁰, and the one in that of Miravittles et al can probably be explained for the most part by greater severity in the subjects in the latter study.

Another strength of the present study was the control over the quality of spirometry, which differentiates ours from other studies published to date. This can compensate for any under- or overestimation due to the inclusion of patients with previous diagnoses of COPD.

The cost of health care services (ambulatory and hospital care) was estimated using a single database (SOIKOS), which in 1997 contained information from 280 sources. The use of this database minimized the variability of costs among the 7 geographic areas in which the study was done.

The present study has certain limitations. As we have already mentioned, units of cost were calculated retrospectively over the previous year. Another limitation is that only 79 of the 363 subjects with COPD (22%) had been previously diagnosed, and hence the cost was obtained from these 79 subjects. As severity in the population studied was mild, the percentage of patients with COPD requiring hospitalization was low (9% of the previously diagnosed patients and 2% of the total identified as having the disease), and the cost of hospitalizations was also calculated on the basis of this sample. Another possible limitation may be attributable to the fact that the prevalence of COPD in the IBERPOC study was calculated using a population between the ages of 40 and 69 years. Given that prevalence may increase with age,¹⁹ failure to include a population over the age of 70 years may have led to underestimation of the prevalence, and consequently to a lower cost of COPD in Spain. All of these limitations may have resulted in an underestimation of cost. However, as already mentioned, the overall cost was comparable to the one

[†]Calculation of cost starts from total figures for health care expenditures on the national level for all diseases. Subsequently, a breakdown process is used to arrive at the disease under study.

estimated in another Spanish study and the percentage of total cost for each component was similar in all 3 (Table 8).

The cost of oxygen therapy was 7 times less than that of usual drug therapy. This contrasts with other bottom-up studies in which the relative cost of oxygen therapy was found to be higher.^{7,17} Home oxygen therapy was used by 0.6% of the total number of subjects, and 2.5% of previously diagnosed patients. In the study by Miravittles et al⁷ of a clinical practice population with a mean FEV₁ of 56%, the percentage of home oxygen therapy was 10%, and here again the differences in severity between the 2 populations may explain the disparity. The present study suggests the untruth of the commonly held belief that oxygen therapy is the major component of the cost of COPD treatment, if we compare it to the cost of usual drug therapy. This same observation was made in another Spanish COPD cost analysis³⁰ and in other countries of the European Union.¹² Inhaled corticosteroids accounted for 45% of the cost of usual drug therapy, which was 22% greater than that of ipratropium bromide; another Spanish study found similar results.⁷ The cost of drug therapy for exacerbations represented more than a third of the total cost of drug therapy (usual plus exacerbations), and more than 90% of the total was generated by antibiotics and inhaled corticosteroids. These data reveal an excessive consumption of these drugs, far above recommended use,³¹⁻³³ especially with respect to inhaled corticosteroids, as only 10% of COPD patients are expected to benefit from them. The cost of inhaled corticosteroids, furthermore, may have been underestimated in the present study, as fluticasone was not on the market in Spain in 1997.

The cost of hospitalization accounted for 69% of the total cost of health care services and 41% of total expenditure. One Spanish study³⁴ found this cost to account for between 58% and 72% of the cost of exacerbations, and most of the studies done on the cost of treating COPD concur that it represents the main cost variable.

In ambulatory care the cost of spirometry was exceeded considerably by that of blood tests, electrocardiograms, and chest x-rays. There were 5 times more blood tests, and 2.5 times more electrocardiograms and chest x-rays performed than spirometries. Miravittles et al⁷ made similar observations in another Spanish study. Again these data show that the management of COPD patients deviates from recommended practice, with underuse of spirometry and overuse of other resources. Spirometry is the test that gives the most information about COPD severity, and its proper use can guide proper management of the disease. The underuse of spirometry is evident in the underdiagnosis of the disease, as only 23% of the 363 cases of COPD had been previously diagnosed.

The cost of severe COPD is 7 times higher than that of mild COPD and 3 times that of moderate COPD

(Table 6). A similar trend was observed in the 3 bottom-up studies in which costs were analyzed according to severity,^{7,12,17} although the cost per person in our study was considerably lower for reasons explained above. In these same studies the percentage distribution of costs was similar to the one in ours, with hospital care and drug therapy accounting for the greatest costs in the treatment of severe COPD. These costs were dramatically lower in moderate COPD and especially in mild COPD. The percentages of cost generated by hospitalization are similar in moderate and severe COPD (Figure). This was also seen in other studies using severity criteria for COPD different from those used in ours (the criteria of the American Thoracic Society⁷ and British Thoracic Society¹²). The explanation for this may lie in the fact that the high cost of hospitalization in absolute terms has an impact on the overall cost of moderate COPD that is similar to its impact on severe COPD.

From the estimates of the present study we can deduce that there is a need to optimize the resources used to manage and treat COPD. Hospitalization is the most expensive component, for which reason any measure aimed at reducing hospital stays will reduce costs considerably. One study estimated that a 50% reduction in the rate of treatment failure for exacerbations would result in a saving of 33% of the total cost of exacerbations, due chiefly to reduced hospitalization.³⁴ As severe COPD requires the most frequent hospitalization, avoiding the worsening of the disease will reduce the cost. In order to achieve this, early diagnosis is essential.

Deviation from the health care practices recommended by scientific societies³¹⁻³⁰ means an unnecessary expense of 62%,³⁰ of which 81% is attributable to underdiagnosis in early stages.

In summary, in the present study—the first to estimate the cost of COPD in a representative sample of the general population—the cost obtained was lower than that of studies analyzing selected samples based on previous COPD diagnoses. The cost distribution does not seem to be in line with recommended health care practices, underlining the need to optimize the resources used in monitoring and treating the disease, with special emphasis on early diagnosis.

REFERENCES

1. Pauwels RA, Buist AS, Calverley PMA, Jenkins CR, Hurd SS. Global strategy for the diagnosis, management and prevention of chronic obstructive pulmonary disease: NHLBI/WHO Global Initiative for Chronic Obstructive Lung Disease (GOLD) Workshop summary. *Am J Respir Crit Care Med* 2001;163:1256-76.
2. Fact sheet: chronic obstructive pulmonary disease (COPD). New York: American Lung Association, 2001. Available at http://www.lungusa.org/pub/minority/mldd_OO.html
3. Statistical abstract of the United States, 2000. Washington D.C.: Census Bureau, 2000; p. 91.
4. Ministerio de Sanidad y Consumo. Plan de Salud 1995. Centro de Publicaciones. Secretaría General Técnica. Madrid: Ministerio de

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- Sanidad y Consumo, 1995.
- Morera Prat J. Enfermedad pulmonar obstructiva crónica. Magnitud del problema. In: *Enfermedad pulmonar obstructiva crónica. Conceptos generales*. Vol. 1. Barcelona: MCR, 1992; p. 57-65.
 - Gabinete de Estudios Sociológicos Bernard Krief. Impacto social y económico de la EPOC en España. Madrid: Zambon-SEPAR, 1995.
 - Miravittles M, Murio C, Guerrero T, Gisbert R. Costs of chronic bronchitis and COPD. A one year follow-up study. *Chest* 2003;123:784-91.
 - Grupo DAFNE. Costes directos de la bronquitis crónica en atención primaria. Análisis de un estudio prospectivo. *Aten Primaria* 2001;27:388-94.
 - Jacobson L, Hertzman P, Löfdahl CG, Skoogh BE, Lindgren B. The economic impact of asthma and chronic obstructive pulmonary disease (COPD) in Sweden in 1980 and 1991. *Respir Med* 2000;94:247-55.
 - Rutten van Mölken MPMH, Postma MJ, Joore MA, Van Genugten MLL, Leidl R, Jager JC. Current and future medical costs of asthma and chronic obstructive pulmonary disease in the Netherlands. *Respir Med* 2000;93:779-87.
 - Dal Negro R, Berto P, Tognella S, Quareni L. Global Outcomes in Lung Disease Study Group. Cost-of-illness of lung disease in the TriVeneto Region, Italy: the GOLD Study. *Monaldi Arch Chest Dis* 2002;57:1-9.
 - Jansson SA, Andersson F, Borg S, Ericsson A, Jonson E, Lundbäck B. Costs of COPD in Sweden according to disease severity. *Chest* 2002;122:1994-2002.
 - Pride NB, Vermeire P, Allegra L. Diagnostic labels applied to model case histories of chronic airflow obstruction. Responses to a questionnaire in 11 North American and Western European countries. *Eur Respir J* 1989;2:702-9.
 - National Heart, Lung and Blood Institute. Morbidity & mortality: chartbook on cardiovascular, lung and blood diseases. Bethesda, MD: US Department of Health and Human Services, Public Health Service, National Institutes of Health, 1998.
 - Grasso ME, Weller WE, Shaffer TJ, Diette GB, Anderson GF. Capitation, managed care, and chronic obstructive pulmonary disease. *Am J Respir Crit Care Med* 1998;158:133-8.
 - National Health Service Executive. Burdens of disease: a discussion document. London: Department of Health, 1996.
 - Hilleman DE, Dewan N, Malesker M, Friedman M. Pharmacoeconomic evaluation of COPD. *Chest* 2000;118:1278-85.
 - Wilson L, Devine EB, So K. Direct medical costs of chronic obstructive pulmonary disease: chronic bronchitis and emphysema. *Respir Med* 2000;94:204-13.
 - Sobradillo V, Miravittles M, Gabriel R, Jiménez CA, Villasante C, Masa JF, et al. Geographic variations in prevalence and underdiagnosis of COPD. Results of the IBERPOC multicentric epidemiological study. *Chest* 2000;118:981-9.
 - Gabriel R, Villasante C, Pino JM, García F, Miravittles M, Jiménez CA. Estimación de la variabilidad inicial interobservador de la espirometría forzada en el estudio multicéntrico IBERPOC. *Arch Bronconeumol* 1997;33:300-5.
 - Miravittles M, Sobradillo V, Villasante C, Gabriel R, Masa JF, Jiménez CA, et al. Estudio epidemiológico de la EPOC en España (IBERPOC): reclutamiento y trabajo de campo. *Arch Bronconeumol* 1999;35:152-8.
 - American Thoracic Society. Standardization of spirometry, 1987 update. *Am Rev Respir Dis* 1987;136:1285-98.
 - Roca J, Sanchis J, Agustí-Vidal A, Segarra F, Navajas D, Rodríguez-Roisin R, et al. Spirometric reference values from a Mediterranean population. *Bull Eur Physiopathol Respir* 1986;22:217-24.
 - Minette A, Aresini G, Sanna-Randacio F. ECSC questionnaire for the study of respiratory symptoms. 3rd ed. Luxemburg: Commission of the European Communities, 1988.
 - Siafakas NM, Vermeire P, Pride NB, Paoletti P, Gibson J, Howard P, et al. Optimal assessment and management of chronic obstructive pulmonary disease (COPD). The European Respiratory Society Task Force. *Eur Respir J* 1995;8:1398-420.
 - Vademécum internacional. Madrid: Medicom, 1997.
 - Gisbert R, Brosa M. Costes sanitarios y evaluación económica. Barcelona: SOIKOS, S.L., 1998.
 - Soler N, Torres A, Ewig S, González J, Celis R, El-Ebiary M, et al. Bronchial microbial patterns in severe exacerbations of chronic obstructive pulmonary disease (COPD) requiring mechanical ventilation. *Am J Respir Crit Care Med* 1998;157:1498-505.
 - Loukides S, Polyzogopoulos D. The effect of diabetes mellitus on the outcome of patients with chronic obstructive pulmonary disease exacerbated due to respiratory infections. *Respiration* 1996;63:170-3.
 - Miravittles M, Figueras M. El coste de la enfermedad pulmonar obstructiva crónica en España. Opciones para una optimización de recursos. *Arch Bronconeumol* 2001;37:388-93.
 - Celli BR, Zinder GL, Heffner J, Tiej B, Ziment I, Make B, et al. Standards for the diagnosis and care of patients with chronic obstructive pulmonary disease. *Am J Respir Crit Care Med* 1995;152: S77-S120.
 - Montemayor T, Alfageme Y, Escudero C, Morera J, Sánchez L. Normativa sobre diagnóstico y tratamiento de la enfermedad pulmonar obstructiva crónica. *Arch Bronconeumol* 1996;32:285-301.
 - Barnes PJ. Chronic obstructive pulmonary disease. *N Engl J Med* 2000;343:269-80.
 - Miravittles M, Murio C, Guerrero T, Gisbert R; Dafne study group. Pharmacoeconomic evaluation of acute exacerbations of chronic bronchitis and COPD. *Chest* 2002;121:1449-55.
 - Strassels CA; Smith DH, Sullivan SD, Mahajan PS. The costs of treating COPD in the United States. *Chest* 2001;119:344-52.