

## Cost and Management of Asthma Exacerbations in Spanish Hospitals (COAX Study in Hospital Services)

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**OBJECTIVE:** The prevalence and associated health cost of asthma have been increasing in developed countries, and 70% of the overall disease cost is due to exacerbations. The primary objective of this study was to determine the hospital cost of an asthma exacerbation in Spain. The secondary objective was to determine what maintenance treatments patients were using to control asthma before the exacerbation and how the exacerbation was treated. The study formed part of a broader study (COAX II), with the same objectives in each of the 8 participating European countries.

**PATIENTS AND METHODS:** Prospective observational study that enrolled 126 patients with an asthma exacerbation treated in the usual way in 6 Spanish hospitals over a 3-month period (from January 1 to March 31, 2000).

**RESULTS:** According to the criteria of the Global Initiative for Asthma, 33.3% of the exacerbations were mild, 38.9% moderate, 26.2% severe, and 1.6% were associated with risk of imminent respiratory arrest. Use of corticosteroids was widespread among patients with moderate and severe asthma, but only 68% of the patients with severe asthma used long-acting  $\beta_2$  agonists. The mean cost was €1555.70 (95% confidence interval [CI], €1237.60–€1907.00), of which 93.8% (€1460.60; 95% CI, €1152.50–€1779.40) was due to direct costs, and 6.2% (€95.1; 95% CI, €35.5–€177) to indirect costs. Cost rose with increasing severity of the exacerbation—€292.60 for a mild exacerbation, €1230.50 for a moderate exacerbation, and €3543.10 for a severe exacerbation.

**CONCLUSIONS:** The mean cost was €1555.70. The costs of moderate and severe exacerbations were 4 and 12 times that of a mild exacerbation, respectively. Long-acting  $\beta_2$  agonists were less widely used than recommended by the guidelines for treatment of moderate and severe persistent asthma leading to asthma exacerbations.

**Key words:** Asthma. Resource management. Hospital care. Asthma exacerbation.

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Coste y manejo de una crisis asmática en el ámbito hospitalario de nuestro medio (estudio COAX en servicios hospitalarios)

**OBJETIVO:** La prevalencia y el gasto sanitario originado por el asma están aumentando progresivamente en los países desarrollados. El 70% del coste total está producido por exacerbaciones. El objetivo principal del estudio fue conocer el coste hospitalario de una crisis asmática en nuestro medio. Como objetivo secundario se quiso conocer cuál era el tratamiento de mantenimiento para el control del asma que utilizaban los pacientes antes de la agudización asmática y su tratamiento. El estudio formaba parte de uno más amplio (COAX II) realizado en 8 países europeos que pretendía los mismos objetivos en cada país.

**PACIENTES Y MÉTODOS:** Estudio observacional prospectivo en el que se incluyó a 126 pacientes con crisis asmática tratados de forma habitual en 6 hospitales españoles durante un período de 3 meses (del 1 de enero al 31 de marzo de 2000).

**RESULTADOS:** Siguiendo los criterios de la Global Initiative for Asthma, el 33,3% de las crisis fueron leves, el 38,9% moderadas, el 26,2% graves y el 1,6% con riesgo de parada respiratoria inminente. La utilización de corticoides era generalizada en los pacientes con asma moderada y grave, pero sólo el 68% de los pacientes con asma grave seguían tratamiento con agonistas  $\beta_2$  de larga duración. El coste medio fue de 1.555,7 € (intervalo de confianza [IC] del 95%, 1.237,6–1.907), el 93,8% (1.460,6 €; IC del 95%, 1.152,5–1.779,4) debido a costes directos y el 6,2% (95,1 €; IC del 95%, 35,5–177) a costes indirectos. El coste se incrementaba a medida que la crisis era más grave: 292,6 € para una crisis leve, 1.230,5 € para la crisis moderada y 3.543,1 € para la crisis grave.

**CONCLUSIONES:** El coste medio fue de 1.555,7 €. Los costes de las crisis moderadas y graves eran 4 y 12 veces mayores que los de la leve, respectivamente. Se observó una infrutilización de los  $\beta_2$  de larga duración con respecto a las recomendaciones de las guías en el tratamiento del asma persistente moderada y grave que originaba crisis de asma.

**Palabras clave:** Asma. Utilización de recursos. Atención hospitalaria. Crisis asmática.

## Introduction

Asthma is a chronic inflammatory disease whose prevalence is steadily increasing in developed countries. With this increase, the disease has become an important health and economic problem due to increased strain on the health care budget and loss of productivity, though such problems can be avoided in most patients with asthma.<sup>1</sup> Few studies have been done to quantify the associated health costs, and some of those available are confusing because of the different ways in which health systems are organized in the countries where the studies were done.<sup>2,3</sup> In Spain, Plaza<sup>3</sup> and Serra-Batlles et al<sup>4</sup> have reported on the relationship between the cost of asthma and disease severity. They followed a cohort of asthmatic patients who were either stable or had poorly controlled symptoms for 1 year. Even though the study subjects did not have an exacerbation at the time of selection, the authors emphasized the importance of the contribution of asthma exacerbations to the total cost of the disease. Almost all indirect costs and a third of direct costs were related to exacerbations and poor control of the disease. Such costs accounted for between 70% and 75% of the total cost.<sup>3,4</sup> These findings suggest that control is unsatisfactory, a situation that could be avoided with correct disease management by the patient and his or her family as well as by the physicians of the health system.<sup>5</sup>

One way to improve asthma control and so reduce the cost associated with the disease is to improve the level of education, and so improve compliance and decrease the number of visits to the emergency room, unscheduled visits to the physician, admission to hospital, and days off work. Another proposal is to improve control of the disease through use of preventative medicine such as inhaled corticosteroids in the early phases of asthma. This might increase drug costs in the short term, but the total cost would decrease in the long term because disease control would improve and the costs of exacerbations would decrease.<sup>1,5</sup> Closer monitoring of asthmatic patients has also been proposed,<sup>6</sup> given that, unlike other chronic diseases, asthma can present at young ages and affect the health and quality of life of the patients for the rest of their lives.<sup>7</sup> Finally, we should mention the need for continual training of health professionals so that they are aware of the content of national and international guidelines for asthma and apply these guidelines. However, at present, neither the cost of an asthma exacerbation itself nor the best management procedure for patients during the exacerbation have been studied in order to optimize intervention strategies for asthmatic patients, improve disease control, and, ultimately, reduce the economic burden of the disease. A first step toward correct and effective understanding of the cost of a disease is to determine its impact by conducting cost analyses.<sup>8</sup>

The objectives of the present study were to estimate the cost of an asthma exacerbation and to determine

what maintenance treatment was used by patients to control their disease before their exacerbation and how the exacerbation was treated.

## Patients and Methods

This prospective observational study was done in the following 6 Spanish hospitals: Hospital San Jorge, Huesca; Hospital Virgen del Puerto, in Plasencia, Cáceres; Hospital Comarcal de Laredo, Santander; Hospital de Gandía, Valencia; Hospital Nuestra Señora del Pino, Las Palmas de Gran Canaria; and Hospital Nuestra Señora de Sonsoles, Avila. A total of 126 patients (21 in each hospital) with asthma exacerbations were sequentially recruited between January 1 and March 31, 2000. No intervention was performed and patients received normal treatment. The direct and indirect costs of the exacerbation were calculated for each patient.

Patients who met the following inclusion criteria were entered: *a*) patients with an asthma exacerbation who attended the emergency room or the outpatient clinic in an unscheduled visit; *b*) patients aged 14 years or older; *c*) patients with a confirmed diagnosis of asthma regardless of disease severity; and *d*) patients who were not participating in a clinical study. If a patient experienced more than one exacerbation during the study period, only the first exacerbation was assessed. We were careful to record the moment of resolution of the exacerbation accurately, and the cost was assessed up until this time of resolution when the patient was clinically stable. We could therefore discard the possibility that a second exacerbation was actually associated with a first exacerbation that had not fully resolved. Lack of compliance with any of the inclusion criteria was considered as an exclusion criterion.

Given that the present study formed part of a broader international study, the definition of an exacerbation established by the Global Initiative for Asthma (GINA) was applied.<sup>1</sup>

## Economic Analysis

The cost analysis was done within the framework of the Spanish National Health System<sup>9</sup> with a breakdown by severity of the exacerbation and by prior severity of the disease. Both direct and indirect costs were included.<sup>10</sup>

To assess the health resources used (visits, admissions to hospital, drugs, tests, etc), we used data available from official sources at the time of the analysis in the year 2000, as well as the drug database of the General Council of the Official Pharmacist Association<sup>11</sup> and the database of Spanish Health Costs of SOIKOS.<sup>12</sup> This database is updated every year and contains costs taken from information on health resources published in Spain.

Direct costs included medication taken for the exacerbation, visits to the physician, visits to the specialist, diagnostic tests, devices used, and visits to the emergency room. Indirect costs were work time lost. The cost of an exacerbation per patient was estimated.

## Data Processing and Analysis

Data were entered into a SAS database and processed with the SAS statistical package. The costs analysis and calculation of the 95% confidence intervals (CI) were done by the bootstrap method.<sup>13</sup> The CI level used was 95%.

To assess the relationship between the severity of the asthma exacerbation and the severity of asthma prior to the exacerbation, correlations were calculated using the SPSS 11.0 statistical package. Correlations were considered statistically significant if *P* was less than .05.

## Results

A total of 126 patients with asthma exacerbations who had come to the emergency room of one of the participating hospitals were included. Of these patients, 34 (27%) were men and 92 (73%) were women. The mean age was 50.2 years (95% CI, 9.7-90.7 years). At the time of the asthma exacerbation, 26 patients were in gainful employment (20.6%; 14 men and 12 women)

and their mean age was 38 years (95% CI, 14.9-61.1 years).

As shown in Table 1, the breakdown by severity showed that most patients had moderate exacerbations (38.9%). An overall statistically significant correlation between the severity of asthma before the exacerbation and the severity of the exacerbation was observed, but 24% of severe exacerbations occurred in patients with a prior diagnosis of intermittent asthma. Table 2 shows the maintenance therapy used before the exacerbation according to the severity of the exacerbation. Table 3 presents the maintenance therapy before the exacerbation according to the severity of the prior disease.

At least 41% of the patients had not received prior medical attention and/or treatment for the exacerbation

TABLE 1  
Relationship Between Prior Asthma Severity and Severity of the Exacerbation\*

Prior Severity	Severity of the Exacerbation				
	Mild	Moderate	Severe	NF	Total
Intermittent	18 (43)	9 (18)	8 (24)	0	35 (28)
Mild persistent	14 (33)	17 (35)	7 (21)	0	38 (30)
Moderate persistent	6 (14)	16 (33)	10 (30)	2 (100)	34 (27)
Severe persistent	4 (10)	7 (14)	8 (24)	0	19 (15)
Total	42 (33.3)	49 (38.9)	33 (26.2)	2 (1.6)	126

\*Data presented as number (percentage). Correlation test statistically significant between prior asthma severity and severity of the exacerbation (*P*<.05). NF indicates near fatal.

TABLE 2  
Prior Maintenance Medication According to the Severity of the Exacerbation\*

Medication	Severity of the Exacerbation				
	Mild (n=42)	Moderate (n=49)	Severe (n=33)	NF (n=2)	Total (n=126)
Oral corticosteroids	3 (7)	6 (12)	5 (15)	0	14 (11)
Inhaled corticosteroids	25 (60)	33 (67)	20 (61)	1 (50)	79 (63)
Short-acting $\beta_2$ agonists	41 (98)	42 (86)	25 (76)	1 (50)	109 (87)
Long-acting $\beta_2$ agonists	18 (43)	22 (45)	14 (42)	2 (100)	56 (44)
Theophyllines	2 (5)	3 (6)	9 (27)	2 (100)	16 (13)
Antileukotrienes	3 (7)	14 (28)	2 (6)	0	19 (15)
Anticholinergics	3 (7)	7 (14)	4 (12)	0	14 (11)

\*Data are expressed as number (percentage). NF indicates near fatal.

TABLE 3  
Maintenance Medication According to Prior Asthma Severity

Medication	Asthma Severity Prior to the Exacerbation				
	Intermittent (n=35)	Mild Persistent (n=38)	Moderate Persistent (n=34)	Severe Persistent (n=19)	Total (n=126)
Oral corticosteroids	0	1 (3)	3 (9)	10 (53)	14 (11)
Inhaled corticosteroids	7 (20)	26 (68)	30 (88)	16 (84)	79 (63)
Short-acting $\beta_2$ agonists	31 (89)	34 (89)	27 (79)	17 (89)	109 (87)
Long-acting $\beta_2$ agonists	1 (3)	16 (42)	26 (76)	13 (68)	56 (44)
Theophyllines	0	3 (8)	7 (21)	6 (32)	16 (13)
Antileukotrienes	0	5 (13)	7 (21)	7 (37)	19 (15)
Anticholinergics	0	0	8 (24)	6 (32)	14 (11)

\*Data are expressed as number (percentage).

TABLE 4  
Origin of Patients and Exacerbation Management in the Emergency Room\*

Medication	Severity of the Exacerbation				
	Mild (n=42)	Moderate (n=49)	Severe (n=33)	NF (n=2)	Total (n=126)
Patients referred from primary health care	15 (36)	20 (41)	13 (39)	0	48 (38)
Patients transported by ambulance	1 (2)	8 (16)	9 (27)	1 (50)	19 (15)
Patients not attended previously by a health care professional and/or prior treatment for the exacerbation	20 (48)	22 (45)	8 (24)	2 (100)	52 (41)
Initial management in the emergency room	27 (64)	42 (86)	33 (100)	2 (100)	104 (83)
Admission from the emergency room	4 (10)	19 (39)	31 (94)	2 (100)	56 (44)
No. of tests per patient	3.7	8	13.6	11	8.1
Peak expiratory flow measurement	12 (29)	16 (33)	10 (30)	0	38 (30)
Arterial blood gas measurement	17 (40)	33 (67)	33 (100)	2 (100)	85 (67)
Electrocardiogram	4 (10)	27 (55)	30 (91)	1 (50)	62 (49)
Chest x-ray	20 (48)	38 (78)	31 (94)	2 (100)	91 (72)
Bacteriology	0	5 (10)	5 (15)	0	10 (8)

\*Data are expressed as number (percentage).  
NF indicates near fatal.

TABLE 5  
Treatment of Asthma Exacerbations\*

Medication	Severity of the Exacerbation				
	Mild (n=42)	Moderate (n=49)	Severe (n=33)	NF (n=2)	Total (n=126)
Systemic corticosteroids	28 (67)	44 (90)	32 (97)	2 (100)	106 (84)
Inhaled corticosteroids	20 (48)	37 (76)	26 (79)	2 (100)	85 (67)
Short-acting $\beta_2$ agonists	26 (62)	44 (90)	33 (100)	2 (100)	105 (83)
Long-acting $\beta_2$ agonists	12 (29)	21 (43)	16 (48)	0	49 (39)
Theophyllines	1 (2)	11 (22)	12 (36)	2 (100)	26 (21)
Antileukotrienes	0	4 (8)	2 (6)	0	6 (5)
Anticholinergics	10 (23.8)	25 (51)	30 (90.9)	2 (100)	67 (53.1)
Antibiotics	17 (40)	22 (45)	18 (55)	1 (50)	58 (46)
Oxygen therapy	12 (29)	28 (57)	31 (94)	2 (100)	73 (58)
Spacer device	4 (10)	4 (8)	6 (18)	2 (100)	16 (13)
Nebulizer	10 (24)	13 (27)	17 (52)	1 (50)	41 (33)

\*Data are expressed as number (percentage).  
NF indicates near fatal.

(Table 4). Once in hospital, 83% of the exacerbations were managed initially in the emergency room, and 56 patients (44%) were subsequently admitted to hospital. The mean number of diagnostic tests per patient was 8.1; the most common procedures were chest x-ray (72%) and basal arterial blood gas analysis (67%). Peak expiratory flow was measured in the emergency room in 30% of the patients and forced spirometry was done on discharge from hospital in 37%.

As shown in Table 5, the most widely used pharmacological treatments were systemic corticosteroids (84%) and short-acting  $\beta_2$  agonists (83%). An increase in usage of drugs in all therapeutic

groups, including antibiotics, was seen with increased severity of the exacerbation.

Finally, all exacerbations resolved in hospital (either in the emergency room or on the ward), except for 1 patient, who continued home treatment under the guidance of his family physician (Table 6). Within 8 weeks, 10% of the patients had been readmitted to hospital after resolution of the exacerbation. The mean number of working days lost during the exacerbation among patients in employment was 19.5 days.

The primary objective of the study was to estimate the cost of an asthma exacerbation treated in hospital. The mean cost was €1555.70 (95% CI, €1237.60-

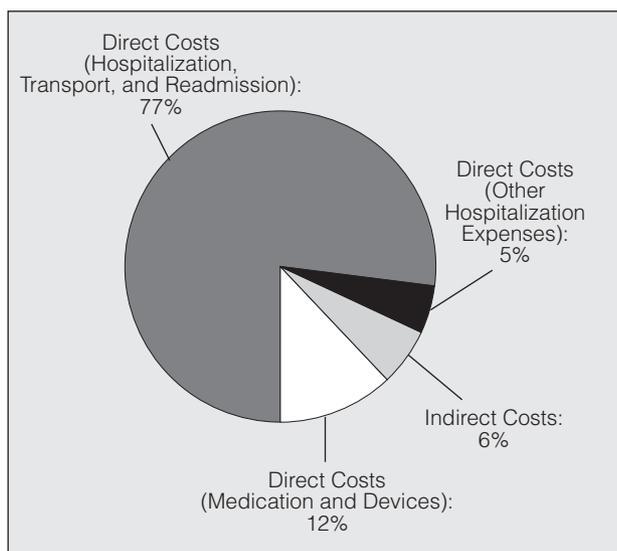


Figure 1. Direct and indirect costs of the exacerbations.

€1907), of which 93.8% (€1460.60; 95% CI, €1152.50-€1779.40) was due to direct costs and 6.2% (€95.10; 95% CI, €35.50-€177.00) to indirect costs. The cost per admission to hospital, transport, and readmission (€1207.30; 95% CI, €955.00-€1470.20) accounted for 77% of the total cost and 82.6% of the direct cost. The cost due to medication, oxygen therapy, and inhalation devices was €195.70 (95% CI, €150.50-€240.90), which accounted for 12% of the total cost and 13.4% of the direct cost (Figure 1).

Figure 2 presents a breakdown of the costs according to the severity of the exacerbation. The greater the severity, the greater the total cost of the exacerbation. Thus, a mild exacerbation cost €292.60 (95% CI, €176.00-€452.40), but this cost increased 4-fold for a

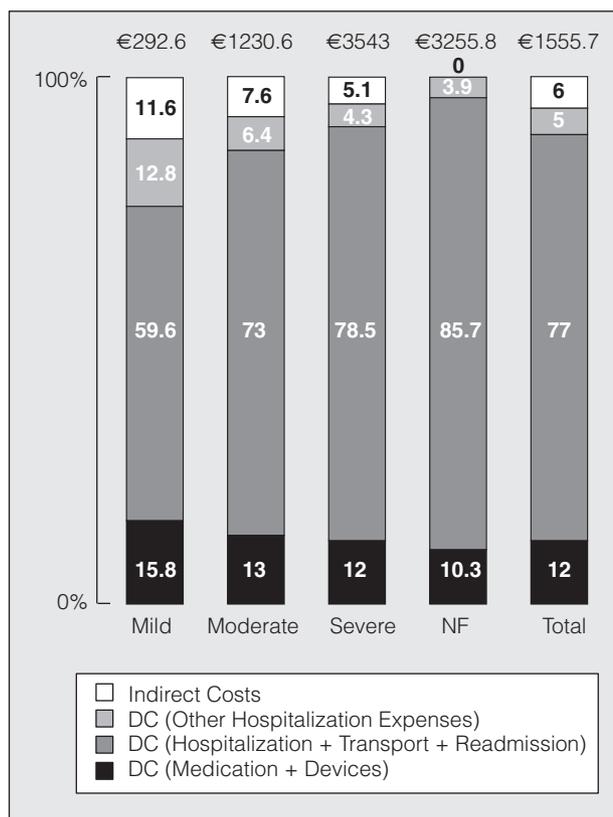


Figure 2. Costs according to the severity of the exacerbation. NF indicates near fatal; DC, direct costs.

moderate exacerbation (€1230.50; 95% CI, €860.60-€1605.80) and up to 12-fold for a severe exacerbation (€3543.10; 95% CI, €2908.70-€4191.30). Even though all types of cost increased as the severity of the exacerbation increased, there was a gradual increase in the relative contribution of the cost due to admission to

TABLE 6  
Resolution and Management on Discharge\*

Medication	Severity of the Exacerbation				
	Mild (n=42)	Moderate (n=49)	Severe (n=33)	NF (n=2)	Total (n=126)
Exacerbations resolved at secondary health care level	42 (100)	48 (98)	33 (100)	2 (100)	125 (>99)
Days of symptoms prior to medical attention	3.6	6	7.1	2.5	5.4
Working days lost	8.5	20.8	27	-	19.5
Patients referred to primary health care	3 (7)	6 (12)	6 (18)	0	15 (12)
Patients referred to specialist outpatient clinics	23 (55)	28 (57)	17 (52)	1 (50)	69 (55)
Patients who received a written plan for asthma management	30 (71)	27 (55)	20 (61)	1 (50)	78 (62)
Forced spirometry on discharge	9 (21)	20 (41)	17 (52)	0	46 (37)
Readmission in the following 8 weeks	2 (5)	6 (12)	5 (15)	0	13 (10)

\*Data are expressed as number (percentage).  
NF indicates near fatal.

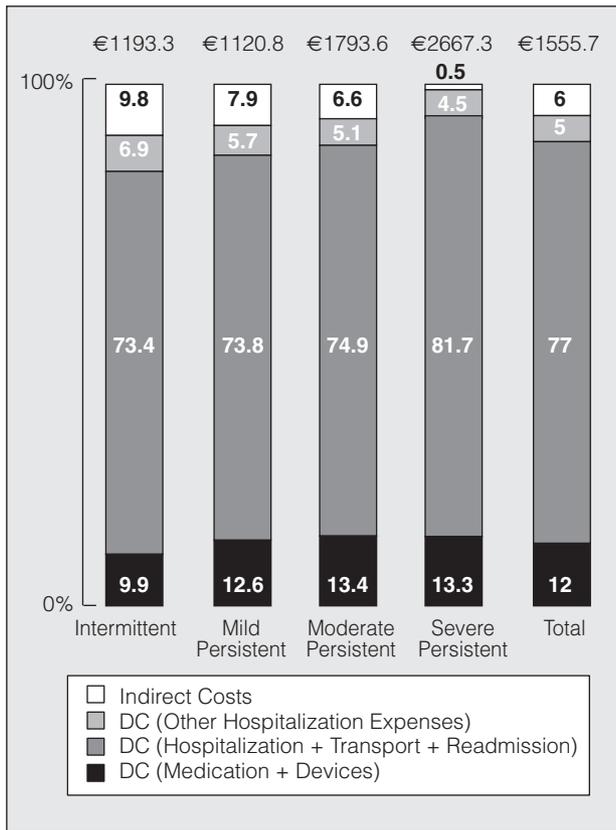


Figure 3. Costs according to prior severity of asthma. DC indicates direct costs.

hospital, transport and readmission, and a decrease in the relative contribution of the other types of cost studied.

The cost analysis according to prior asthma severity (Figure 3) showed that the cost of a patient with severe persistent asthma (€2667.30; 95% CI, €1582.70-€3987.60) was 2.2 times that of an exacerbation in a patient with intermittent asthma (€1193.30; 95% CI, €714.20-€1760.20).

Finally, Figures 4 and 5 show costs of the drugs used for the asthma exacerbation and for prevention of the exacerbation, respectively, as a percentage of the total drug costs.

### Discussion

The economic burden of a disease can be studied descriptively by analyzing its cost from different points of view (that of society, patients, or health care providers), but such an approach does not assess the outcome of a given intervention or treatment. Alternatively, a cost-benefit or cost-effectiveness analysis can be done to provide information about possible savings resulting from the outcome obtained. The findings from such an analysis would allow the needs, changes, and policies for future action to be assessed for a given disease.<sup>8,14</sup> Health care costs can be divided into 3 groups, namely, direct costs, indirect costs, and intangible costs. Direct costs are related to resources used (drugs, visits to the clinic, admissions to

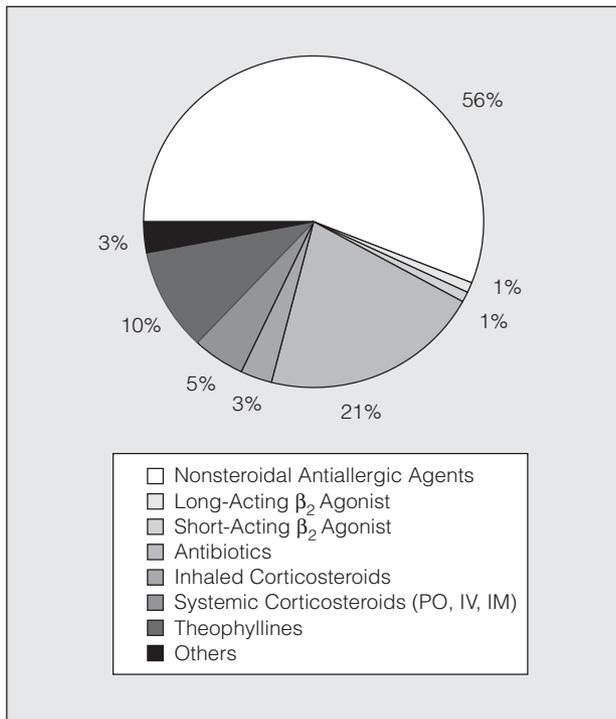


Figure 4. Cost of drugs for an asthma exacerbation. PO indicates oral administration; IV, intravenous administration; IM, intramuscular administration.

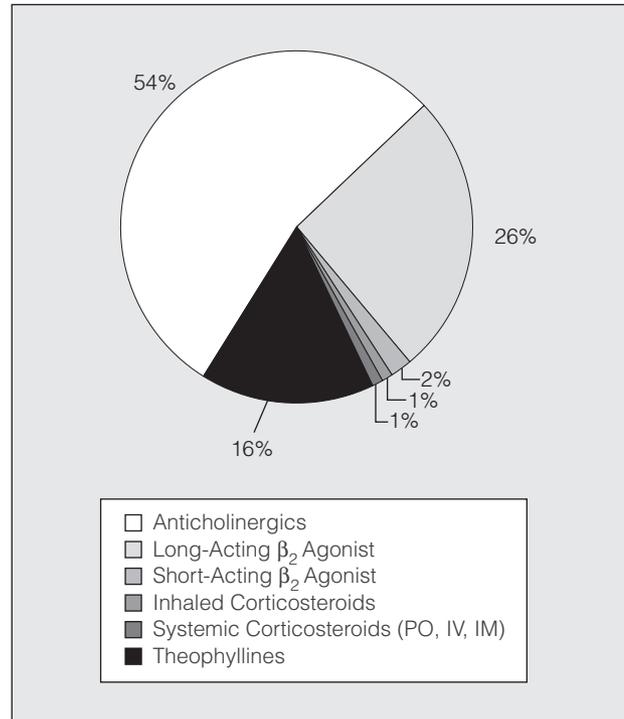


Figure 5. Cost of drugs for maintenance treatment in asthma. PO indicates oral administration; IV, intravenous administration; IM, intramuscular administration.

hospital, diagnostic tests, and cost of health care staff) and can be readily quantified. Indirect costs are related to the loss of productivity due to the disease (sick leave, work disabilities, early retirement, and premature deaths). Quantification of these costs varies from country to country according to the labor situation and public health care system, the age of the patients, and the severity of the disease. Intangible costs are related to possible economic earnings not obtained due to physical and/or psychological problems associated with the disease. Given that such costs are very hard to quantify, the studies available estimate the impact of asthma on the life of the patient with quality-of-life questionnaires.<sup>3</sup>

The severity of prior asthma and the severity of the exacerbation are correlated, such that mild exacerbations are more common in patients with mild intermittent or persistent asthma, moderate exacerbations in patients with mild and moderate persistent asthma, and severe exacerbations in patients with moderate and severe persistent asthma. Nevertheless, 24% of the patients who developed severe exacerbations were diagnosed with intermittent asthma. Although certain allergens, stimuli, or triggers may be strong enough to provoke a severe exacerbation, it is also possible that the severity of the asthma was incorrectly classified in these patients.

Following international guidelines,<sup>1</sup> inhaled corticosteroids were used by 68% of the patients with mild persistent asthma, 88% of those with moderate persistent asthma, and 84% of those with severe persistent asthma, and 11% of the patients received treatment with oral corticosteroids. Concomitant antiinflammatory treatment with antileukotrienes was taken by 15% in an attempt to control the disease while reducing or at least not increasing the dose of inhaled corticosteroids. Antileukotrienes were therefore used almost exclusively in patients with moderate and severe asthma (21% and 37% of the patients, respectively). On the other hand, only 44% of the patients were receiving preventative treatment with long-acting  $\beta_2$  agonists, even though guidelines recommend treatment with these drugs in patients with moderate and severe asthma. Treatment with long-acting  $\beta_2$  agonists was not being taken regularly by 24% of the patients with moderate asthma and 32% of those with severe asthma. The reasons for this are not clear because the initial study objectives did not include the collection such data. We can only speculate that when the study was done, a high level of evidence for the benefits of such treatment for chronic moderate and severe asthma was not available, in contrast to the undisputed benefits of treatment with inhaled corticosteroids. As in the study of Jatulis et al,<sup>15</sup> we saw more widespread use of antiinflammatory agents with greater asthma severity, but the total use of inhaled corticosteroids in our study was greater than in the population study of Rabe et al<sup>16</sup> (23%). Our findings do agree, however, with those reported by López-Viña et al<sup>17</sup> (65%) in a study of asthmatic patients treated in primary health care.

The above results suggest that the classification of asthma and treatment according to the degrees of severity of the GINA were essentially appropriate,<sup>1</sup> but we did see that only 61% of those with a severe exacerbation had received previous treatment with inhaled corticosteroids. This is in agreement with Barnes et al,<sup>5</sup> who suggest that underuse of preventative medication leads to a greater use of emergency services.

In the management of the exacerbation in the emergency room, treatment with systemic corticosteroids and short-acting bronchodilators is adequate. However, it is noteworthy that 41% of the patients had not received any type of medical attention for the exacerbation before attending the emergency room. This suggests that some of these patients were undertreated or undiagnosed, but the study made no attempt to assess possible reasons for this, such as lack of treatment plans, self-management, or education of asthmatic patients. On discharge from the emergency room, all patients were given a report, but only 61% of those who suffered a severe exacerbation and 55% of those with a moderate exacerbation were given a self-care plan for asthma in writing, compared to 71% of those with a mild exacerbation. This is because the drugs and doses given to patients with more severe exacerbations figure in the discharge report and physicians do not want these patients self-administering the medication, with the exception of certain patients with a broad understanding of the disease. These findings are similar to those of López-Viña et al,<sup>17</sup> who observed that pulmonologists had issued a self-treatment plan in writing to 66% of their patients, and primary health care physicians had done so to 61%.

Some exacerbations have a rapid onset. Up to 20% of near-fatal asthma exacerbations in Spain have a rapid onset (less than 2 hours), and the most common causes are nonsteroidal antiinflammatory drugs, food, sulfites, exposure to environmental allergens, and inhalation of irritant smoke.<sup>18,19</sup> Often, the patient has mild asthma or stable asthma. Although our study did not aim to investigate the triggers, those leading to rapid-onset exacerbations may have repercussions when analyzing direct care in emergency rooms because they are severe. They may also affect the analysis of duration, as rapid-onset exacerbations resolve more quickly than those that begin more slowly.

Likewise, peak expiratory flow was only measured in 30% of the patients, and it was not possible to measure in some patients with severe exacerbations because of their respiratory situation. In the study by López-Viña et al,<sup>17</sup> the peak expiratory flow was only determined during 69% of visits to the pulmonologist and during 15% of those to the general practitioner. These findings reflect how little this parameter is used, particularly in primary health care and emergency rooms, and they also reveal how little is known about its usefulness, application, or interpretation, despite being a test that can be readily done, both in primary health care and in emergency services. The number of spirometry tests

done on discharge increases with increasing severity of the exacerbation, although the percentage of patients who were discharged after spirometry testing was very low (37%).

It is possible that 55% of the patients were subsequently referred to specialist clinics only because of the previous findings we report (that is, lack of control of asthma in severe exacerbations, patients with no health education on asthma or its treatment) or because of protocols followed in the emergency services. This could lead to a greater dependence on the specialist (pulmonology, allergology, etc) or on the hospital emergency service.

The aim of this study was to estimate the cost of an asthma exacerbation in the setting of the emergency room. The mean cost was €1555.70, most of which was accounted for by direct costs (93.8%). Of the total, 77% was due to hospitalization, transport, and readmission, and 6.2% to indirect costs. Therefore, these findings agree with the thesis of Plaza<sup>3</sup> and Barnes et al,<sup>5</sup> who indicate that more than 70% of the total cost of asthma is preventable and is due to poor control.

We found that the costs increase as severity increases as seen in other studies<sup>20-22</sup>; thus, the cost of a moderate exacerbation is 4-fold that of a mild exacerbation, and the cost of a severe exacerbation can be as much as 12 times that of a mild exacerbation. These figures show that the cost of an exacerbation in patients with more severe prior disease may be up to 2.2 times greater than in patients with intermittent asthma, but what is really important is the severity of the exacerbation—a severe exacerbation is more harmful to the patient and much more costly to the health system, regardless of the prior disease severity. Thus, it is important that the disease is satisfactorily controlled, whatever the severity.

Several authors have pointed out that a large share of the resources is spent on a small number of patients,<sup>4,23-25</sup> that is, those who have most severe asthma and those who suffer severe exacerbations. These authors have also pointed out that the costs of patients with mild intermittent or persistent asthma are generally due to drug costs, whereas the costs of those with moderate and severe persistent asthma are due more to hospitalizations and visits to the emergency room, with the amount spent on drugs being inversely proportional to hospitalization costs.<sup>3,8</sup>

To conclude, we can state that a high percentage of patients suffer severe exacerbations due mainly to lack of preventative treatment and self-treatment plans, despite acceptable classification of asthma and treatment prescribed for the disease in patients with asthma exacerbations. We can also affirm that pharmacological treatment of exacerbations in the emergency room is appropriate in most cases. As for the economic burden of the disease, we emphasize that it is important to prevent severe exacerbations and so reduce costs. To this end, the disease can be controlled by a number of means, of which preventative antiinflammatory treatment<sup>25,26</sup> and self-management programs and education of the

asthmatic patient are the most studied and best tested.<sup>27-30</sup> Elderly patients, those with diseases that might deteriorate with asthma exacerbations, and those who have suffered an exacerbation in recent months are particularly worthy of attention, as these patients have been associated with a sharp increase in the costs derived from the disease.<sup>31</sup>

The study is subject to a number of limitations, such as the small number of patient centers, its duration, under representation of the economically active population in the sample (20.6%), and the fact that costs incurred by family members or partners were not included (time off work, cover by colleagues, etc). The study formed part of an international study in hospitals in 8 European countries (COAX II study),<sup>32</sup> and so the GINA classification was used to allow comparison of data among the different countries. The use of the GEMA (Spanish Guidelines for Asthma Management) classification might affect some of the results. Moreover, if the study had been done today, there would probably have been changes in the maintenance treatment of the asthmatic patients; in particular, antileukotrienes and add-on drug combinations would be more widely used. Now is the time for new studies in a larger population with a longer follow up. Particularly important would be cost-effectiveness studies which, in addition to the usual parameters, include health-related quality of life to assess the most appropriate strategies in order to improve disease control and so reduce asthma exacerbations, visits to the emergency room, and hospitalizations.

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BORDERÍAS CLAU L, ET AL. COST AND MANAGEMENT OF ASTHMA EXACERBATIONS  
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