

# The Economic Burden of COPD\*

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**COPD is one of the leading causes of morbidity and mortality worldwide and imparts a substantial economic burden on individuals and society. Despite the intense interest in COPD among clinicians and researchers, there is a paucity of data on health-care utilization, costs, and social burden in this population. The total economic costs of COPD morbidity and mortality in the United States were estimated at \$23.9 billion in 1993. Direct treatments for COPD-related illness accounted for \$14.7 billion, and the remaining \$9.2 billion were indirect morbidity and premature mortality estimated as lost future earnings. Similar data from another US study suggest that 10% of persons with COPD account for > 70% of all medical care costs. International studies of trends in COPD-related hospitalization indicate that although the average length of stay has decreased since 1972, admissions per 1,000 persons per year for COPD have increased in all age groups > 45 years of age. These trends reflect population aging, smoking patterns, institutional factors, and treatment practices.**

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**Abbreviation:** LVRS = lung volume reduction surgery

In many countries, the gap between individual expectation for access to medical services and the availability of societal resources for health care has widened. Those that finance health-care services are searching for ways to minimize the cost impact of chronic disease, whereas those who deliver health services seek to optimize the health of those under their care. The goals of minimizing cost and optimizing health often are in conflict, particularly in an era of health-care budget constraints, competing needs for limited government budgets, rising prices, and an aging and changing population. Because the process of allocating scarce resources among competing medical treatments can be emotional and politically charged, decision makers would prefer to turn to rational and consistent methods of evaluation that are designed to maximize the amount of health for a population under a health-care budget constraint. An immediate consequence is that more emphasis should be placed on understanding the social, functional, and economic burden of illness and the cost-effectiveness of prevention strategies and treatments. This has led to increasingly important information needs for medical and policy decision makers concerning the following: (1) the epidemiologic conditions and burden of disease; (2) the availability and

disposition of resources for health (cost of illness); (3) the institutional and policy environment; and (4) the cost-effectiveness of available technologies and strategies for health improvement.

The intent of this article is to summarize the available evidence on disease burden, cost of illness, and cost-effectiveness of interventions as they relate to COPD.

COPD is one of the leading causes of morbidity and mortality worldwide, and the functional and medical care resource consequences of COPD on individuals, families, health-care organizations, and society are substantial. Still, detailed information at a global or regional level concerning disease burden statistics for COPD is extremely scarce. Very few studies have quantified the economic and monetary consequences of the morbidity, premature mortality, and disability associated with COPD. None of these studies has been conducted outside of North America or western Europe.

In this article, we describe what is known about the social and economic consequences of COPD. We also present a summary of the literature on the cost-effectiveness of smoking-cessation programs and on pharmacologic and nonpharmacologic treatments.

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## ECONOMIC BURDEN OF DISEASE

Economic burden, or *cost-of-illness*, studies provide insight into the economic impact that illness has on society as well as on individuals and families. This

approach separates economic burden into disease-attributable direct and indirect costs. The direct costs are those associated with medical management of the illness. Indirect costs are those associated with output losses and family costs as a consequence of illness (loss of work time and productivity).

Chronic bronchitis and emphysema exert a heavy toll on society. According to estimates from the National Heart, Lung, and Blood Institute, the annual cost of COPD to the United States was \$23.9 billion in 1993.<sup>1</sup> This included \$14.7 billion in direct expenditures for medical care services, \$4.7 billion in indirect morbidity costs, and \$4.5 billion in costs related to premature mortality. The largest contributor to the cost of COPD is hospitalization.

The prevalence of chronic bronchitis and emphysema in 1993 was 15.7 million cases or 61.9 per 1,000 persons.<sup>2</sup> Combining disease prevalence and illness burden, COPD costs an average of \$1,522 per person per year, or almost three times the per capita cost of asthma. Table 1 displays comparable estimates of the direct and indirect costs of lung diseases.

In another study of COPD-related illness costs, Sullivan and colleagues<sup>3</sup> studied the National Medical Expenditure Survey to define the contribution of individual cost components to overall illness burden. The data indicated that the largest proportion of total expenditures was for inpatient hospitalization and emergency department care (72.8%). Outpatient clinic and office visits accounted for 15.0% of expenditures, and prescription drug costs were responsible for 12.2%. Expenditures were disproportionately distributed, with 10% of patients accounting for 73% of expenditures.

Expenditures for Medicare beneficiaries with COPD have been shown to be nearly 2.5 times higher than *per capita* total expenditures of those without COPD (\$8,482 vs \$3,511).<sup>4</sup> As with other serious chronic conditions, the most severely affected individuals incur a substantial share of all costs associated with the condition in the population. Nearly 50% of the total Medicare payments for those with COPD were incurred by approximately 10% of the Medicare beneficiaries with COPD.<sup>1</sup>

Hospitalization-related costs, the largest portion of all expenditures for patients with COPD, commonly occur in the latter stages of the disease. The National Medical Expenditure Survey study estimated that *per capita* expenditures for inpatient hospitalizations in the COPD cohort were 2.7 times the *per capita* expenditures of the non-COPD cohort (\$5,409 vs \$2,001). Treatments that could prevent or limit hospitalizations could substantially impact the overall burden of this disease.

Data from the United Kingdom's Office of National Statistics showed that there were some 203,193 hospital admissions for COPD in Northern Ireland, Scotland, Wales, and England in 1994.<sup>5</sup> The average length of hospital stay among those admitted for a COPD diagnosis was 9.9 days. The National Health Service Executive published data in 1996 showing that the medical cost of COPD in the United Kingdom was approximately £846 million or £1,154 (about \$2,300) per person per year.<sup>6</sup> Of the total estimated economic burden of COPD in the United Kingdom, £402 million (47.5%) was for expenditures for pharmaceutical treatments, £207 million (24.5%) was for ambulatory oxygen therapy, £151 million (17.8%) was for hospital-based care, and the remainder (10.2%) was for primary care and community-based services. Expenditures for COPD-related medical care in Sweden was estimated at £115 million in 1991.<sup>7</sup> The estimated indirect cost of COPD in Sweden was an additional £152 million. Thus, unlike in the United States, the relative indirect cost of COPD in Sweden exceeded the direct medical care cost.

#### TRENDS IN COPD HOSPITAL DISCHARGES

Expenditures for hospitalizations represent > 70% of all COPD-related medical care costs. Thus, it is important to understand the trends in hospital-related care for COPD. Using data from the National Hospital Discharge Survey, investigators at the National Center for Health Statistics evaluated the trends in COPD-related hospital discharges. The first listed diagnosis on the hospital medical record

**Table 1—Comparison of Direct and Indirect Costs of Lung Diseases in 1993\***

Condition	Total Costs	Direct Medical Costs	Mortality	Morbidity	Total
COPD	23.9	14.7	4.5	4.7	9.2
Asthma	12.6	9.8	0.9	0.9	2.8
Influenza	14.6	1.4	0.1	13.1	13.2
Pneumonia	7.8	1.7	4.6	1.5	6.1
Tuberculosis	1.1	0.7	—	—	0.4
Respiratory cancer	25.1	5.1	17.1	2.9	20.0

\*Adapted from the Division of Epidemiology, National Heart, Lung, and Blood Institute.<sup>1</sup> Values given in billions of 1993 US dollars.

identified the discharge as being COPD related. In the United States, an estimated 553,000 hospital discharges were reported in 1995, a rate of 21.2 per 10,000 population. Between 1992 and 1995, the overall discharge rate increased by 25.4%.

The age-specific trend in overall hospital discharge rate from 1980 to 1995 for chronic bronchitis and emphysema is depicted in Figure 1. Most discharges (67.1% in 1995) are in the population that is > 65 years of age, and the discharge rate in this age group is more than four times that in the 45- to 64-year-old age group. Differences may exist between data reported from 1988 to 1995 and those in earlier years because of the redesign in the National Hospital Discharge Survey. Also, the International Classification of Diseases (ninth revision) code for chronic bronchitis changed in 1992.

### Cost and Cost-Effectiveness of Treatment Alternatives

When considering the impact of alternative therapies for emphysema and chronic bronchitis on the economic burden of the disease, it is most useful to examine the costs of individual treatments in relation to the best alternative therapy or therapies.

Sclar et al<sup>8</sup> analyzed the health service expenditures of COPD patients treated with pharmacotherapy. Their study estimated the expenditures of newly diagnosed COPD patients for prescriptions, physicians, laboratory work, and hospital services during a period of 15 months. The results were adjusted for age, sex, comorbid diseases, lung function, and treatments. The average estimated costs of health care for

an individual during a 15-month period ranged from \$596 to \$954 in 1994 dollars.

Investing resources in smoking-cessation programs is cost-effective in terms of medical costs per year of life gained. A recent international review of > 310 cost-effectiveness studies found that the median societal cost of various smoking-cessation interventions was approximately £17,000 per year of life gained.<sup>9</sup> The literature on smoking-cessation cost-effectiveness studies reports on face-to-face interventions such as nicotine transdermal patches, physician and other health professional counseling with and without patches, self-help and group programs, and community-based stop-smoking contests. Similarly, a comprehensive guidance document published in *Thorax* showed that smoking-cessation programs produced cost-effectiveness ratios that ranged from £212 to £873 per year of life gained and were, thus, a very good health-care value for the National Health Service.<sup>10</sup>

Supplemental home oxygen is usually the most costly component of outpatient therapy for adults with emphysema who require this therapy.<sup>11</sup> Reviews of the cost-effectiveness of alternative outpatient oxygen delivery methods suggest that oxygen concentrator devices may be cost-saving compared with cylinder delivery systems.<sup>12</sup>

Education and pulmonary rehabilitation programs have been shown to have beneficial effects in patients with COPD.<sup>13</sup> Education programs have been promoted as an economically attractive intervention for individuals with COPD.<sup>14</sup> A Canadian study found the incremental cost of pulmonary

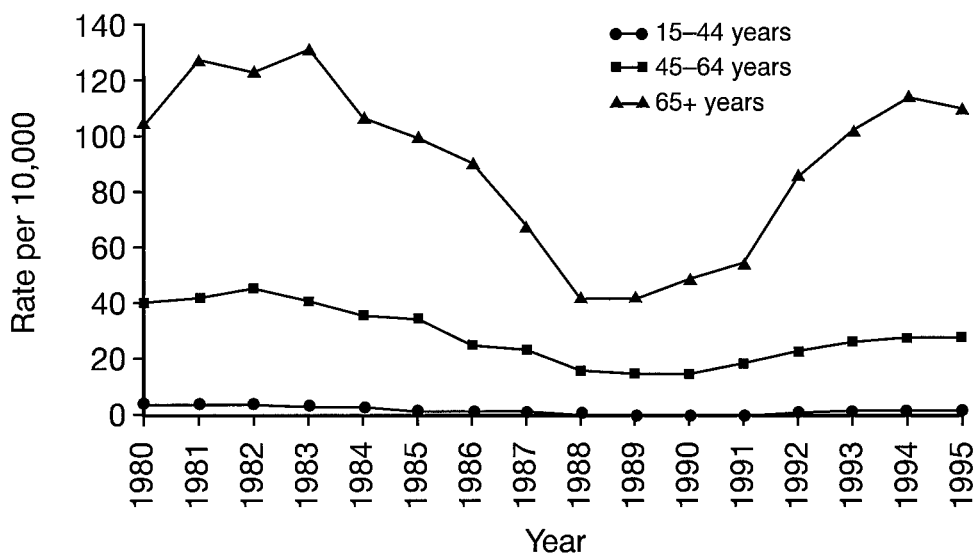


FIGURE 1. US age-specific COPD hospital discharge trends from 1980 to 1995.

rehabilitation to be \$11,597 per person (in Canadian dollars). Statistically significant improvements in dyspnea, fatigue, emotional health, and mastery were observed.<sup>15</sup>

An observational study with a small number of subjects found that patients in a pulmonary rehabilitation program used fewer health-care services compared with those without rehabilitation.<sup>16</sup> Because of study design limitations, it is unclear whether these results can be generalized to a larger, more diverse group of patients. The initial costs of the rehabilitation program may be offset if urgent care and emergency department visits or hospitalizations are subsequently reduced.

Lung volume reduction surgery (LVRS) has become an available option for treating severely disabling emphysema.<sup>17</sup> Considerable debate has centered on the role of LVRS in treating emphysema because evidence from controlled studies is lacking. It has been projected that widespread adoption of this procedure could cost the US health economy more than \$6 billion in the first several years of adoption.<sup>18</sup> The Health Care Financing Administration has stated that Medicare will no longer provide reimbursement for LVRS until sufficient evidence exists regarding the safety and efficacy of the treatment.

A number of studies have estimated costs for LVRS. Elpern and colleagues<sup>19</sup> analyzed the hospital costs associated with LVRS in 52 consecutive patients. Total hospital costs ranged from \$11,712 to \$121,829 and were significantly associated with length of stay in the hospital, both in the ICU and in total length of stay. A small number of individuals incurred extraordinary costs because of complications. The mean cost was \$30,976, and the median cost was \$19,771. Advanced age was a significant factor leading to higher expected total hospital costs.

Albert and colleagues<sup>20</sup> also evaluated the hospital charges in 23 consecutive patients admitted to undergo LVRS at a single institution. Charges ranged from \$20,032 to \$75,561, with a median charge of \$26,669. The results from this study suggest that the costs of LVRS will fall as complication rates are reduced and as average length of stay falls with time, as caregivers gain experience with the procedure.

Lung transplantation is a costly but often effective therapy for severe emphysema. Ramsey and colleagues<sup>21</sup> examined the hospitalization costs associated with lung transplantation. Other studies of lifetime expenditures for lung transplantation have ranged from \$110,000 to well over \$200,000.<sup>22,23</sup> Unlike LVRS, the costs associated with lung transplantation remain elevated for months to years after surgery because of the high cost of complications and immunosuppression regimens.

## COST-EFFECTIVENESS OF PHARMACOLOGIC TREATMENTS

Rutten-van Mölken and associates<sup>24</sup> investigated the costs and effects of adding inhaled anti-inflammatory therapy to inhaled  $\beta_2$ -agonist therapy by analyzing data from a randomized trial of 274 adult participants aged 18 to 60 years. Patients were selected for inclusion if they met the age criteria and had been diagnosed as having moderately severe obstructive airway disease, as defined by pulmonary function criteria. Patients were eligible if they had either asthma or COPD, but most patients had asthma. Each patient was randomized to receive either fixed-dose inhaled terbutaline plus inhaled placebo, inhaled terbutaline plus 800  $\mu\text{g}$  inhaled beclomethasone per day, or inhaled terbutaline plus inhaled ipratropium bromide, 160  $\mu\text{g}/\text{d}$ . Patients were followed up for up to 2.5 years or until premature withdrawal.

The objective of this study was to determine the relative cost per unit of benefit for the three therapeutic arms. The clinical results indicated that addition of the inhaled corticosteroid to fixed-dose terbutaline led to a significant improvement in pulmonary function ( $\text{FEV}_1$  and the provocative dose of a substance causing 20% fall in  $\text{FEV}_1$ ) and symptom-free days, whereas addition of the inhaled ipratropium bromide to fixed-dose terbutaline produced no significant clinical benefits over placebo. The average annual monetary savings associated with the use of inhaled corticosteroids were not offset by the increase in costs from the average annual price of the inhaled product. The incremental cost-effectiveness for inhaled corticosteroid was \$201 per 10% improvement in  $\text{FEV}_1$  and \$5 per symptom-free day gained. The incremental cost-effectiveness of ipratropium bromide was not evaluated because of the lack of clinical benefit relative to placebo.

Jubran and colleagues<sup>25</sup> performed a retrospective, chart-based cost-minimization analysis of theophylline vs ipratropium bromide for patients with COPD. They found that patients treated with ipratropium had lower costs and a greater number of complication-free months compared with those taking theophylline.

A *post hoc* pharmacoeconomic evaluation of two multicenter, randomized trials comparing salbutamol plus ipratropium with salbutamol alone and ipratropium alone in a total of 1,067 patients with COPD was conducted by Friedman et al.<sup>26</sup> Data on outcomes and the total cost of treatment were compared. The authors concluded that the inclusion of ipratropium in a pharmacologic treatment regimen was associated with a lower rate of exacerba-



tions, lower overall treatment costs, and improved cost-effectiveness. There were, however, no differences in total costs between the ipratropium-alone and salbutamol-plus-ipratropium treatment arms.

## CONCLUSION

Because COPD is highly prevalent and can be severely disabling, medical expenditures for treating COPD can represent a substantial economic burden for societies and for public and private health insurers worldwide. Nevertheless, very little economic information concerning COPD is available in the literature today. Studies of the economic burden of illness have been conducted in only a few developed countries. Although studies of direct medical-care costs may be less relevant to the developing world, one might hypothesize that the indirect burden of COPD in developing nations may be substantial and important. Because the health-care sector does not provide long-term supportive-care services for severely disabled individuals in most of the developing world, COPD may force two individuals to leave the workplace: the affected individual and a family member who must now stay home to care for the disabled relative. Thus, in terms of productivity lost, COPD may be doubly burdensome for low-income countries. Because human capital is often the most important asset for developing nations, COPD may represent a serious threat to their economies.

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