

PERSPECTIVE

The costs of asthma

P.J. Barnes*, B. Jonsson**, J.B. Klim+

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ABSTRACT: At present, asthma represents a substantial burden on health care resources in all countries so far studied. The costs of asthma are largely due to uncontrolled disease, and are likely to rise as its prevalence and severity increase.

Costs could be significantly reduced if disease control is improved. A large proportion of the total cost of illness is derived from treating the consequences of poor asthma control - direct costs, such as emergency room use and hospitalizations. Indirect costs, which include time off work or school and early retirement, are incurred when the disease is not fully controlled and becomes severe enough to have an effect on daily life. In addition, quality of life assessments show that asthma has a significant socioeconomic impact, not only on the patients themselves, but on the whole family.

Underuse of prescribed therapy, which includes poor compliance, significantly contributes towards the poor control of asthma. The consequences of poor compliance in asthma include increased morbidity and sometimes mortality, and increased health care expenditure. To improve asthma management, international guidelines have been introduced which recommend an increase in the use of prophylactic therapy. The resulting improvements in the control of asthma will reduce the number of hospitalizations associated with asthma, and may ultimately produce a shift with-in direct costs, with subsequent reductions in indirect costs. In addition, costs may be reduced by improving therapeutic interventions and through effective patient education programmes.

This paper reviews current literature on the costs of asthma to assess how effectively money is spent and, by estimating the proportion of the cost attributable to uncontrolled disease, will identify where financial savings might be made.

Eur Respir J., 1996, 9, 636-642.

*National Heart and Lung Institute, Royal Brompton Hospital, UK. **Stockholm School of Economics, Centre for Health Economics, Stockholm, Sweden. +Zeneca Pharmaceuticals, Alderley Park, Macclesfield, UK.

Correspondence: P.J. Barnes
National Heart and Lung Institute
Royal Brompton Hospital
Dovehouse Street
London SW3 6LY
UK

Keywords: Asthma
cost-effectiveness
health care system
therapy

Received: November 14 1995

Accepted after revision January 12 1996

Despite the availability of effective treatments, asthma is increasing in both prevalence and severity [1]. The chronic nature of asthma means that many patients require daily medication for optimal control. However, underuse of currently prescribed therapies has meant that patients require emergency therapy more often, thereby incurring a substantial cost to health care systems. Concern about therapy in asthma has led to the publication of guidelines for asthma therapy [2-4], which recommend the early use of prophylactic therapy in asthma.

Improving the control of asthma through effective intervention is a desirable aim both from the clinical and economic viewpoints. Health care costs are under pressure in all countries, and decisions about the use of new therapies are based not only on safety and tolerability assessments, but also increasingly upon evidence of value for money. Hence, it is important that physicians and health economists work together to understand the costs of asthma, to assess the effectiveness of current asthma therapies, and to know how to achieve optimal cost-effectiveness.

The purpose of this paper is to estimate the proportion of the cost represented by uncontrolled asthma, based on the available literature on the costs of asthma, and to discuss the opportunities for further reductions in the costs of uncontrolled asthma.

Direct and indirect costs of asthma

The direct costs of a disease, defined as resources consumed, include costs associated with drugs and devices, consultations with physicians, and hospital costs. The indirect costs of a disease are defined as resources that are lost, and include time off work as a result of the ill health of the patient, time spent by people looking after the patient in the home, and premature retirement or death (table 1). Whereas direct costs can be accurately assessed, it is more difficult to assess indirect costs, since their valuation depends on a number of social conditions, including the functioning of the labour market. Understanding the costs of asthma will help determine where money is spent and whether it is being spent effectively, and is a first step towards a more precise analysis of where to invest money in the future.

Since data are available on the overall costs of asthma, it is possible, from an understanding of direct and indirect costs of asthma, to estimate the costs of uncontrolled disease.

Nine studies have presented a comprehensive breakdown of the cost components of asthma, and have covered a wide range of countries and health care systems. Two studies were carried out in Australia [5, 6], the UK

Table 1. – Types of cost associated with asthma

Direct costs (resources consumed)	Indirect costs (resources lost)	Intangible cost [#] (quality of life)
Cost of doctors'/nurses' time	Loss of productive work by patient	Grief
Cost of social support (<i>e.g.</i> home help)	Loss of productive work by patient's family and friends (<i>e.g.</i> mother taking time off work to care for child with asthma)	Fear
Cost of drugs		Pain
Cost of hospital treatment	Loss of productive work due to patient's early retirement or premature death	Unhappiness
Cost of disposable equipment		#All of the above apply not only to the patient but also to his/her friends and family
Capital cost of land, buildings, equipment		

[7, 8], and Sweden [9, 10], and one each in the USA [11], Canada [12], and France [13]. The level of detail on costs varied; for example, only two studies considered the indirect costs due to premature mortality, and so this review will only present data on the indirect costs of asthma morbidity and will exclude indirect costs due to asthma mortality. Figure 1 summarizes the relative contributions of direct and indirect costs associated with asthma morbidity for each study. The high variability among the studies may be the result of differences in health care systems among the countries, different data sources, methodological variations, or genuine differences in cost. In particular, the TEELING-SMITH [8] study shows very low direct costs associated with asthma. This may be due to the fact that this early study was carried out when drug costs were low, a component which has risen over time and constitutes a major part of direct costs. Taking the available data together, it is apparent that direct and indirect costs account for approximately equal shares of the total costs.

The pattern of resource consumption will be very different in individual patients depending on the severity of the condition and on age. Unfortunately, accurate data on this issue are lacking. However, in Canada it has been shown that 10% of asthmatic patients account for over

50% of the costs [12]. Emergency care, despite its relatively high use in children, remains a small component of the total cost of childhood asthma (less than 7% of the total) [14].

Direct costs

Direct costs will be determined by disease severity, compliance with medication, the overall prevalence of the disease, and the cost of health care, for example, healthcare costs are higher in the USA. The relative importance of the components which make up direct costs vary widely among the studies (fig. 2). Generally, physician costs make up the smallest component, with the cost of hospitalization being somewhat larger and approximately equal to the cost of drugs, which constitutes the largest component of the direct costs of treating mild-to-moderate asthma.

Physician costs. Three of the studies differentiated physician costs into general and specialist practitioners [5, 6, 12], and one into in-patient and out-patient care [11]. Physician costs average 22%, of which 75% relates to

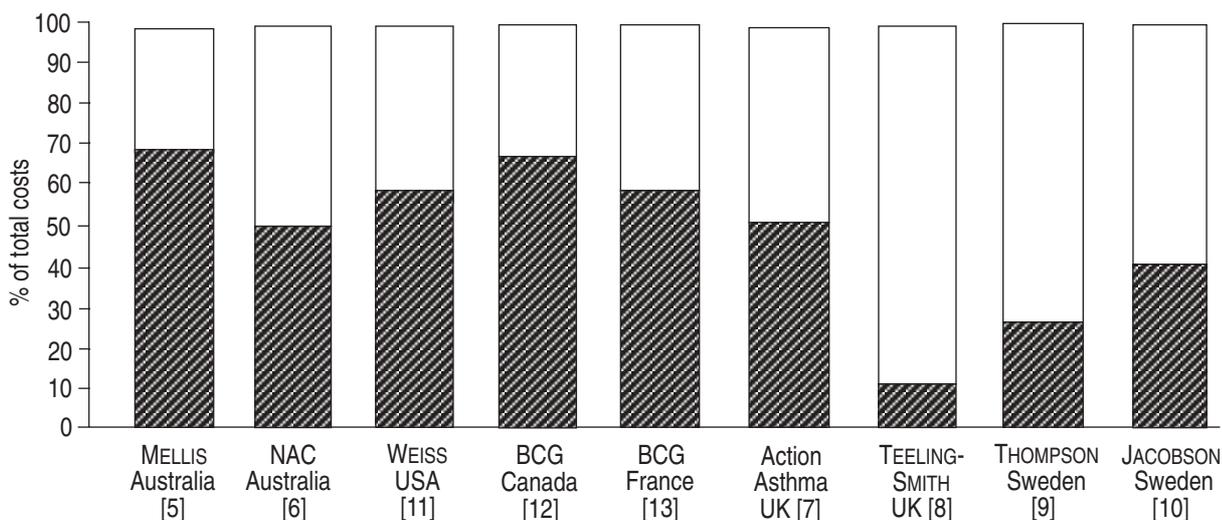


Fig. 1. – Direct and indirect costs of asthma. The first author, country and reference number are given for each study. NAC: National Asthma Campaign; BCG: Boston Consulting Group. ▨ : direct costs; □ : indirect costs.

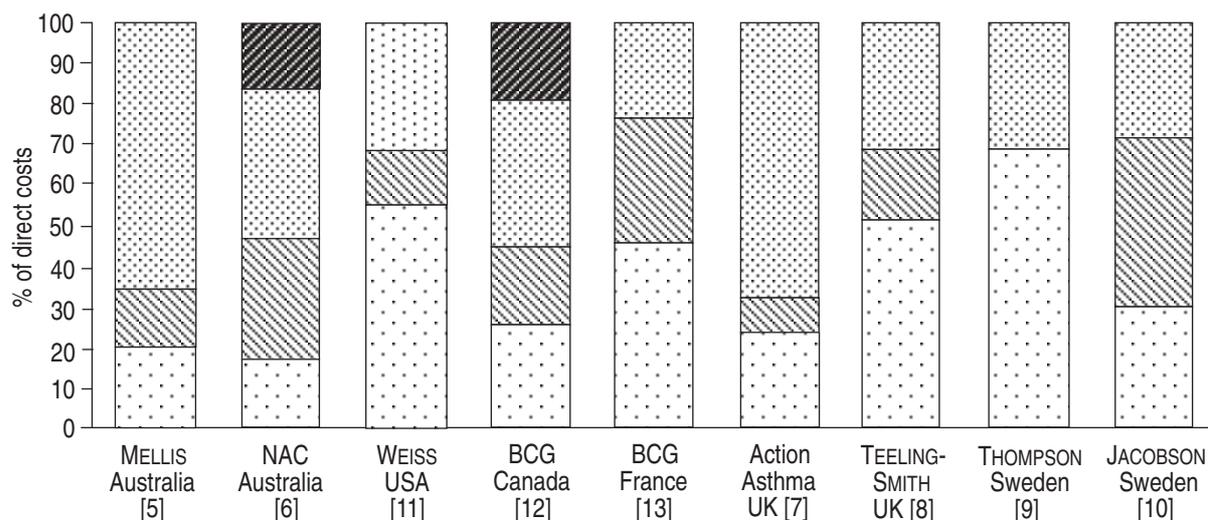


Fig. 2. — Breakdown of direct costs associated with asthma. The first author, country and reference number are given for each study. NAC: National Asthma Campaign; BCG; Boston Consulting Group. □: hospital; ▨: physician; ▩: drugs/devices; ■: others.

general practitioner (GP) consultations and 25% to specialist consultations. Therefore, GP care accounts for the highest proportion of the physician costs. These figures are in agreement with resource data from two additional studies in the UK [15, 16]. If we assume that GP care represents part of the cost of controlling asthma, then asthma treated by specialist physicians represents part of the cost of uncontrolled asthma. Therefore, improvements in asthma management by GPs, which requires greater patient supervision and assessment of control if it is to be successful, may reduce emergency room use and, thus, save money in the long-term.

Drug costs. Drug costs make up approximately 37% of the total direct costs of asthma, and represent the major cost for mild-to-moderate asthmatic patients. Most drugs and devices can reasonably be considered to be part of the cost of controlling asthma, provided that patients are compliant with their medications. Compliance with asthma therapy, and particularly prophylactic therapy, is poor [17–19], and the resulting morbidity incurs significant costs. A recent study by BOSELY *et al.* [20] has shown that only 15% of patients took drugs as directed for more than 80% of the study period.

At present, more money is spent on rescue therapy than on prophylactic therapy, indicating that further improvements in therapy can be made. International management guidelines [2–4] recommend an increase in expenditure on prophylactic therapy, which should reduce reliance on rescue therapy, and, by improving the

control of asthma, may potentially decrease hospital costs with consequent savings in total health care costs. However, current regimens for asthma therapy and delivery systems are complex and patients may have difficulty understanding them.

Hospital costs. Total hospital costs are typically around 20–25% of the direct cost of asthma, although four of the nine studies differed widely from this (table 2). The figure reported by THOMPSON [9] is high because it includes hospital out-patient care, which accounted for over half of all the physician visits in Sweden. The high figure quoted by TEELING-SMITH [8] may relate to the very low estimate for drug costs. WEISS *et al.* [11] reported a high percentage in relation to hospital costs, this may be the result of the relatively high unit cost of in-patient treatment in the USA. To decrease the number of hospitalizations, it is necessary to understand the reasons for hospitalization and to define the population being hospitalized.

Hospital costs are mainly incurred by patients with moderate to severe asthma, and hospitalization usually occurs when the management of asthma has failed to prevent an acute severe attack, which is expensive to rectify [21]. The aim of any health care organization must be to balance the cost of treatment interventions with their benefits.

Five of the nine studies separated hospital costs into their constituent components (table 2). Out-patient treatment is an area of hospital care which is predominantly aimed at controlling asthma, whilst in-patient care, a

Table 2. — Hospital costs associated with asthma

Cost component %	Australia 1991 [5]	Australia 1992 [6]	USA 1992 [11]	Canada 1993 [12]	France 1992 [13]	UK 1990 [7]	UK 1990 [8]	Sweden 1984 [9]	Sweden 1995 [10]
Emergency	18		15	18		} 88		NA	
In-patient	68		76	82				88	
Out-patient	14		9	NA			12	12	
Total hospital costs % of direct costs	22	18	56	27	49	24	53	79	31

NA: not available.

much larger cost, is primarily concerned with treating acute exacerbations of asthma due to a failure of disease control. In-patient costs comprise the most important component of hospital costs (70–85%), whilst emergency room treatment was consistently around 14–18% of the total hospital costs. Children consumed a high proportion of the resources devoted to emergency treatment (45%), but a low proportion of the in-patient costs (24%). Out-patient treatment, the least expensive constituent of hospital care, consistently accounted for the smallest portion of hospital costs (9–14%).

Other direct costs. Other direct costs attributed to asthma include co-morbidity (the additional costs incurred in treating asthmatic patients for other diseases), the cost of home care, expenditure on "alternative medicine", nursing home costs, and the costs of ambulance call-outs.

Indirect costs

Indirect costs only occur when asthma has become sufficiently intrusive to interfere with a patient's lifestyle and are, therefore, mainly associated with uncontrolled asthma.

Indirect costs encompass those costs associated with the loss of productive work by the patient, premature retirement, and time spent by others caring for sick relatives. Indirect costs are sometimes easier to consider in terms of physical resources - for example, the number of working days lost or the number of premature deaths - without attempting to value these units (table 3).

Indirect costs will vary depending on the age of the patient and on the severity of the disease. WEISS *et al.* [11] and LENNEY *et al.* [14] reported that children accounted for a high percentage of indirect costs (39%), reflecting the importance of time spent by others to care for children and the high prevalence of childhood asthma.

Intangible costs

Asthma can significantly impair the quality of a patient's life. Since it cannot be cured, therapy is directed at reducing symptoms to allow the patient to lead a relatively unhindered life. As part of physician-patient cooperation in the management of asthma, it is important to achieve patient satisfaction by obtaining their views and perceptions of the disease. Assessment of these needs and, in particular, assessment of the patient's perception of the impact of asthma on their life is known as measurement of the quality of life. Intangible costs vary with the age of the patient and with the severity of the disease.

A number of instruments have been developed for the formal assessment and measurement of quality of life from the patient's viewpoint, rather than that of the clinician. Those used in asthma include the Nottingham Health Profile [13], the McMaster Questionnaire [22], and St George's Respiratory Questionnaire [23]. Using these, it has been demonstrated that patients with asthma have an impaired quality of life, and that this can be improved by prophylactic treatment [24].

Two studies [7, 13] have considered the impact of asthma on the quality of a patient's life. Although the economic impact of the quality of life has not been assessed, some qualitative data from the UK Action Asthma Survey [7] are available. This study provided questionnaires in pharmacies, GP surgeries and hospital out-patient clinics, which were filled in by asthmatic patients and returned by post. The sample was entirely random, but the strength of the study lay in the large number of respondents: 61,234 in 6 months. Sixty two percent of patients felt that asthma had at least a moderate effect on their lives, and 40% felt that it imposed moderate restrictions on their daily activities. The report suggested that this implied an acceptance among asthmatics of lifestyle restrictions. Unfortunately, the survey did not ask what activities were restricted.

Although paediatric patients with moderate asthma find the respiratory symptoms of the disease troublesome, few children perceive that asthma poses a major disruption to their lives. However, the parents of these children felt that strategies could be implemented by clinicians to ease the common worries and concerns surrounding the child's asthma [25].

The St George's Respiratory Questionnaire has been developed to provide a measure of quality of life in asthma and allows for direct numerical comparisons to be made among patients, study populations, and therapies, and has sensitivity when applied to mild as well as severe disease [23]. This is the most comprehensive questionnaire for the evaluation of quality of life in asthma. Recent studies which have used the St George's Hospital Respiratory Questionnaire have shown that 95% of respondents had an impaired quality of life when compared with age-matched control individuals (fig. 3) [26].

Costs of controlled *versus* uncontrolled disease

Asthma is considered to be a mild illness, which should be managed by ambulatory care. However, on average a third of the direct cost of asthma is related to emergency room use, hospitalization and death. This strongly indicates that there is scope for significant cost reduction by improving disease control.

Table 3. – Indirect costs associated with asthma, presented in terms of physical resources

	Australia 1991 [5]	Australia 1992 [6]	USA 1992 [11]	Canada 1993 [12]	UK 1990 [7]	UK 1990 [8]	Sweden 1984 [9]
Working days lost	40×10 ⁴	52×10 ⁴	≈ 300×10 ⁴	150×10 ⁴	700×10 ⁴	570×10 ⁴	200×10 ⁴
School days lost	NA	50×10 ⁴	>1000×10 ⁴	NA	NA	NA	NA

NA: not available.

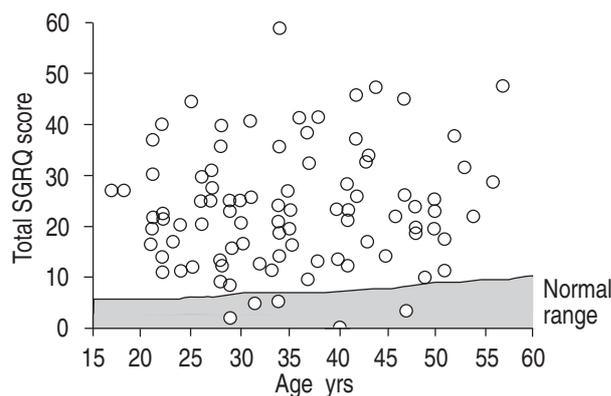


Fig. 3. – Impaired quality of life measured using the St George's Respiratory Questionnaire (SGRQ) in mild asthmatics recruited through their place of work. The shaded area indicates the upper 95% confidence limit for age-matched scores obtained in disease-free subjects. (Reproduced by kind permission of P.W. Jones [26]).

The pattern of cost incurred will vary among asthmatic patients depending on the severity of the disease and the degree of control achieved. Clinicians and health economists perceive "control" differently. The indication of successful control from the clinical viewpoint is the fact that the physician does not see the patient in the clinic, whereas health economists perceive control as the quality of life attained by the patient.

Improved control often results in an increase in drug and general practitioner costs, as patients consult their GPs more often and take more therapy. However, the improved control reduces other costs [27, 28]. For example, controlled asthmatic patients were estimated to require fewer visits to physicians, fewer hospitalizations, and fewer days off work than uncontrolled asthmatic patients, regardless of disease severity.

Three studies have shown that patients with mild asthma account for less than half of the direct costs of asthma, whereas individuals with moderate to severe asthma exerted the greatest strain on the economy [6, 12, 16].

The Glaxo Canada study [12] and the National Asthma Campaign survey [6] in Australia have differentiated costs on the basis of disease severity. Patients with mild asthma required 3–5 visits to their GP annually and one visit to a specialist, with the occasional day off work. Individuals with moderate asthma appeared to contribute more to the burden of asthma, with the study suggesting 6–10 GP visits annually and 2–10 days off work. However, these estimates should perhaps be viewed with a degree of caution, since the study of patients with mild-to-moderate asthma undertaken by WHITEMAN and GADUZO [16], indicated that 68% of patients did not visit their GP at all in the course of a year. In addition, Canadian patients seem to visit doctors more often than Australian patients (4.9 GP visits annually in Canada compared to 2.3–3.6 GP visits in Australia). Unfortunately, no comparative data are available concerning the number of days off work required by individuals with mild-to-moderate asthma, but it is likely to be towards the lower end of the 2–10 day range.

The most striking finding from the three studies, which analysed cost by severity of disease, is the low cost of treating mild-to-moderate asthma. In Canada, this cost was measured at C\$1.58 per patient per day (of which

C\$1.13 was direct cost). In Australia, the cost was 80 cents per patient per day, and drug expenditure accounted for only 23 cents per patient per day. However, given that the cost of treating uncontrolled asthma in hospital is high, it appears that not enough is being done to control asthma.

Effects of intervention on the cost of asthma

Asthma, particularly moderate-to-severe disease, is a significant economic burden. Indirect costs account for 50% of the cost of asthma. Within direct costs, drugs (37%) and GP care (16%) can be assumed to relate to the costs of managing controlled asthma; the remainder (mainly hospital costs) can be assumed to relate to the treatment of failed control. Therefore, on the basis of these assumptions, it appears that approximately three quarters of the total cost appears to be a result of inadequately controlled disease.

Substantial evidence indicates that the costs of uncontrolled asthma (hospitalization, emergency admission, days off work and school) can be significantly reduced by interventions which improve disease management (patient education and prophylactic therapy). Where compared, the savings in the cost of treating uncontrolled asthma far outweighed the additional cost of the control measures. The Australian National Asthma Campaign [6] suggests that, for adults with severe asthma, all categories of direct medical expenditure could be reduced by achieving optimal disease control in all patients.

Prophylactic therapy and reduction of costs

International guidelines [2–4] stress that prophylactic therapy should be introduced at an earlier stage in asthma treatment. Although this will produce a shift within the direct costs of the disease and result in a greater emphasis on drug and GP costs, it will be offset by reductions in hospitalizations and time off work. The cost of one admission to hospital pays for 3 years of treatment with inhaled steroids [21].

A number of studies carried out both retrospectively and prospectively have investigated the relationship between outcome measures which result from poorly controlled asthma and the increased use of prophylactic therapy in asthma management strategies [9, 29–33]. Within the formal clinical trial environment, it has been shown that the higher cost of prophylactic intervention was offset by savings in other aspects of direct health care costs [32–35]. For example, ADELROTH and THOMPSON [33] demonstrated an 80% reduction in hospital bed days following the introduction of high-dose inhaled corticosteroids in patients with severe asthma. More recently, BUXTON and SCULPHER [35] used the number of episode-free days as an outcome in their economic evaluation of formoterol and salbutamol. This study showed that salbutamol was more cost-effective than formoterol because of its lower acquisition cost.

The data generated from clinical trials are consistent with those from audit-based studies. The audit-based studies looked at outcome measures, which included acute exacerbations, hospitalizations, and emergency room use

[29, 31]. In Sweden, the number of hospital bed-days due to asthma declined during the years immediately following the introduction of budesonide in 1973–1974 [9]. A detailed study of hospitalizations for asthma in 14 Swedish county council regions over the years 1978–1989 clearly showed a negative correlation between the use of inhaled corticosteroid therapy and hospitalization [30]. In the USA, Ross *et al.* [29] found that the addition of sodium cromoglycate to asthma treatment regimens for patients with chronic mild asthma, resulted in savings both in emergency treatment and hospital admissions compared with a control group. This outweighed the small increase in medication costs of \$0.09 per patient per day.

Patient education programmes and savings in costs

Asthma education has been shown to improve compliance with medication [36] and other aspects of patient self-management, thereby reducing the number of emergency admissions and hospital care in children [37, 38] and adults [39, 40].

Asthma education helps families and patients to adjust to the demands of the disease [41–43]. Education programmes reduce the number of days taken off work by patients with moderate-to-severe asthma [40], and the number of schooldays missed by asthmatic children [38]. SØNDERGAARD *et al.* [28] showed that a patient education programme resulted in increased GP visits over a 6 month period. These costs were offset by a reduction in days lost from work and an improvement in the patients' quality of life. FIREMAN *et al.* [27] investigated the effect of education on 13 children with chronic asthma (six episodes or more) by a nurse-educator, compared with a similar group of 13 children who did not receive education. The children who received education missed school on 10 times fewer days than the control group, and incurred significantly lower emergency treatment costs and hospitalization costs. A nurse-run asthma clinic for patients with moderate-to-severe asthma set up within a UK general practice resulted in a reduction in GP consultations, days lost from work or school, and episodes of severe asthma [44].

Conclusion

In conclusion, asthma costs are substantial, representing over 1% of total health care costs in the USA [11]. The costs are largely due to uncontrolled disease, indicating that current therapies are either underused or misused in practice. Total annual costs are estimated at £322–686m in the UK [7, 8] and \$5.5bn in the USA [11]. For comparison, the costs of chronic diabetes have been estimated at £260m in the UK [45], and \$19.8bn in the USA [46].

Perhaps surprisingly, for a disease for which effective prophylactic therapies exist, much of the cost of asthma relates to costs which could be avoided or reduced by improved disease control. Indirect costs, such as time off work or school and early retirement, are incurred when the disease is not fully controlled and becomes severe enough to have an effect on daily life. These costs account

for 50% of the cost of illness. In addition, quality of life assessments have shown that asthma has a significant socioeconomic impact, not only on the patients themselves, but on the whole family.

Within direct costs, hospitalization accounts for 20–25%, of which almost all is either in-patient or emergency admission, and therefore attributable to inadequate disease control. Physician costs comprise another 20–30% of direct costs, of which approximately a quarter is related to non-GP services. If it is estimated that all GP services and all drugs and devices are attributable to controlled asthma, it appears that at least 30% of the direct cost of asthma is, therefore, attributable to inadequately controlled disease. When added to the indirect costs, at least three quarters of the total burden of illness are derived from the costs of treating the consequences of poor asthma control.

These costs, both direct and indirect, are amenable to reduction by improved disease control. Asthma hospitalization in Sweden decreased as inhaled corticosteroid use increased. Patient education programmes in various countries have consistently been shown to reduce hospitalizations, GP visits, emergency admissions, and time off work and school, and the savings have always been reported to outweigh the costs of intervention.

Opportunities exist for cost-savings in asthma, particularly in patients with moderate-to-severe disease. However, to utilize resources more efficiently, interventions have to be assessed in terms of their costs, potential cost-savings, and outcomes for patients. Therefore, it is important that health economists and clinicians work together to find out how to optimize expenditure on asthma care.

Acknowledgements: The authors would like to thank P. Jones of St George's Hospital, London, for providing figure 3, and H. Michie of Franklin Scientific Projects, London, for help in producing the manuscript.

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