Eur Respir J, 1993, 6, 1485–1491
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European Respiratory Journal
ISSN 0903 - 1936

Cost-effectiveness of a structured treatment and teaching programme on asthma

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ABSTRACT: The purpose of this study was to perform a cost-effectiveness analysis of the structured treatment and teaching programme for patients with asthma (ATTP) at Düsseldorf University. We investigated whether the monetary benefits outweighed the costs of the intervention.

Adult patients with moderate to severe asthma participated in a 5 day in-patient programme. Follow-up was 3 yrs. The incremental costs and benefits of the intervention, compared with standard treatment, were calculated.

Costs were incurred by the hospitalization and by lost productivity. Compared to the year before the programme, (average reduction) days spent in hospital (5.2 days per patient per year), days of absence from work (18.4 days per patient per year), acute severe asthma attacks (3.8 attacks per patient per year), and physician consultations (2.3 visits per patient per month), decreased in the 3 yrs after the intervention. The programme produced net benefits of DM 12,850 (in 1991 German marks) per patient within 3 yrs. Within the health care sector, the net benefits were DM 5,900. Within 3 yrs, the paying bodies saved DM 2.70, and society as a whole saved DM 5 on each DM spent for the programme.

We conclude that the intervention produced net monetary benefits. This result was stable over a wide range of variation of the outcome measures. Therefore, the programme deserves implementation, not only for its demonstrated medical benefits but also for its economic savings.

Eur Respir J., 1993, 6, 1485–1491.

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Keywords: Absence from work
asthma
cost-effectiveness analysis
health programme evaluation
hospitalization
patient education

Received: November 24 1992
Accepted after revision July 19 1993

Asthma is an important cause of chronic morbidity. In addition to its effects on health and reduction in quality-of-life, asthma has a great economic impact due to the use of hospital care, out-patient care, emergency treatment and drugs, as well as the loss in productivity caused by absence from work [1].

In the health care system, increasing numbers of intervention programmes and treatment schemes compete for limited resources. In practice, selection is often based more on tradition and the peculiarities of a given health care system than on rational criteria. Consequently, selection criteria need substantial improvement. The prior condition should be the proof of medical effectiveness (for many common procedures this has never been demonstrated). In addition, the desired medical benefit should be obtained by the lowest possible consumption of resources. Some analyses of treatment and teaching programmes for asthma patients have been published: HABER *et al.* [2] found improvements in lung function and psychological scores after a teaching programme, which was similar to ours in content, but which was delivered for 10–12 weeks on an out-patient basis. However, they did not include costs in their analysis.

There have only been a few economic evaluations of educational programmes for adults with asthma. WINDSOR *et al.* [3] estimated costs and evaluated therapy adherence, but did not measure the impact on health services utilization. DETER [4] found a reduction in working days lost and in hospitalization days, after one year of out-patient psychosomatic (coping group) therapy. Taking costs into account, the cost/benefit ratio was 1:5. Recently, two randomized controlled studies from Denmark showed lower consumption of some health services after teaching programmes for chronic obstructive pulmonary disease (COPD) and asthma patients [5, 6]. Given the limited data presently available, the effect of educational programmes for patients with asthma on the use of resources for health care and on people's economic productivity deserves further attention.

A treatment and teaching programme for patients with asthma (ATTP), carried out at Düsseldorf University Hospital, was recently demonstrated [7] to improve forced expiratory volume in one second (FEV_1) and total airway resistance, as well as to reduce hospitalizations, acute severe asthma attacks, days of absence from work and physician visits. We performed a further analysis of this intervention. We calculated its incremental costs and benefits expressed in monetary terms, compared to standard treatment of asthma in Germany without any additional intervention. The objective of our study was

to determine whether the incremental benefits outweighed the incremental costs within 3 yrs following the ATTP. We found that this was the case, the intervention producing net monetary benefits within this time period.

Patients and methods

Patients

All patients who were consecutively admitted to the structured ATTP between November 1986 and September 1988 carried out at the University Hospital in Düsseldorf, Germany were eligible for the study if they had a primary diagnosis of asthma, substantiated by a rise in FEV_1, of at least 15% after inhalation of a beta-agonist (142 patients). For calculating the effects on hospitalizations and sick leave days, we included only those patients for which these data were provided by the sickness funds, so that we did not have to rely on subjective information. Only employed patients were included in the analysis of days of absence from work. Atopic status was determined according to previous prick testing or elevated immunoglobulin E (IgE) levels. FEV_1 as % of vital capacity (%VC) and total airway resistance were measured at initial assessment and at follow-up after 1 yr. FEV_1%VC was also measured at examinations after 2 and 3 yrs. Hyperresponsiveness was not systematically tested. Patients with two or more nocturnal asthma attacks per month, with frequent exacerbations, or who used three or more anti-asthmatic compounds were considered to have moderate to severe asthma.

Intervention

The main objectives of the intervention were systematization of drug therapy, with emphasis on preventive maintenance drug therapy [8], structured training of the patients in the self-management of their asthma, and encouragement to assume a considerable amount of decision making responsibility in the treatment of their disease. The ATTP was performed on an in-patient basis, lasting from Monday morning to Friday afternoon, on a general ward of internal medicine. It consisted of 20 h of group teaching, with 4–8 patients per group. The curriculum was designed by a multidisciplinary group of health care professionals. Patient education was undertaken by a specially trained nurse educator. Central topics were: basic information on asthma and the medication for its treatment, peak flow self-monitoring, avoidance of exposure to precipitants of symptoms, use of medication according to symptoms and results of peak flow self-monitoring, self-adaptation of acute and maintenance drug therapy, and management of asthma attacks and intercurrent bronchial infections.

All of the patients included in the study stayed 5 days in the hospital. The participants of the study were seen in our hospital for follow-up examinations 1, 2 and 3 yrs after discharge. Except for these examinations, treatment and check-ups after the teaching programme were carried out by the patients' family doctors. A detailed description of this programme, including the methods of data collection and the results after 1 yr of follow-up, has been published previously [7]. The same methods apply to the collection of the data after 2 and 3 yrs of follow-up.

We included in the cost-effectiveness analysis the effects relevant from the perspective of society as a whole. Therefore, the impact on both health care costs (direct costs and benefits) and lost productivity by absence from work (indirect costs and benefits) were included in the analysis. As an alternative approach, only the costs and savings that are relevant from the perspective of the paying bodies were considered. All calculations were made on the basis of 1991 prices in German marks (DM).

Costs and benefits

The hospitalization for the ATTP caused both direct and indirect costs. For the direct costs, we used the "general" *per diem* price, which is applicable to internal medicine and some other departments. We added the costs of a peak flow meter and of teaching material, as well as the nurse educator's salary, including the payments for pension funds, unemployment insurance and health insurance.

Indirect costs of the ATTP (loss in productivity) were measured by the average salary per day multiplied by the length of stay. We used the average monthly gross salary of workers and employees in the (West) German industry in October 1991, according to the Federal Statistical Office [9].

The average difference of the number of days spent in hospital for all causes before and after the ATTP was calculated for each year of follow-up. After adjustment for the general slight decrease in the duration of hospitalizations between 1986 and 1991, these differences were multiplied by the *per diem* price of an average German hospital. The calculations were made separately for each year of follow-up. The most recent available data for prices (1989) were used, adjusting for increases in prices (5% per year) [10]. The mean difference of days of absence from work before and after the ATTP was calculated for each year of follow-up. Multiplication by the average salary per day resulted in the savings per patient per year from reduced absence from work.

Acute severe asthma attacks were defined as attacks requiring emergency treatment by a physician (provided by a family doctor, at an emergency room in a hospital, by prehospital emergency ambulance care, or by any other physician). The frequency of these attacks in the year preceding a follow-up examination was acquired from the patients by questionnaire. The savings were calculated as the difference between the number of severe asthma attacks before and after the ATTP in all patients, divided by the number of patients and multiplied by the estimated cost of the average treatment for an acute severe asthma attack. This cost was based on the fee of an emergency visit by an office-based physician at the patient's home, including physical examination and an

injection. Fees were calculated by multiplying the applicable scores from the list of physicians' services (BMÄ) [11], by the monetary value of scores in 1991 according to the physicians' association (Kassenärztliche Vereinigung Nordrhein). No fees for additional diagnostic or therapeutic procedures, treatment at night or transport by ambulance were considered. This provided the most conservative estimate of the savings from reduced asthma attacks.

The frequency of physician consultations was also collected from the patients by questionnaire. All visits to office-based physicians, most of them being regular "routine" visits (which are more frequent than emergency interventions alone) were included. The average reduction in consultations per patient per month was multiplied by the cost of a typical follow-up consultation of an asthma patient with an office-based physician, including physical examination and counselling. No additional diagnostic procedures were included, in order to obtain a conservative estimate of the savings. It was assumed that the overall number of diagnostic tests, such as pulmonary function tests, per patient per year was not reduced. We deducted a lump sum charged for visits to the out-patient service of the University Hospital's Pneumology Department from the savings by reduced physician consultations. The calculations for physician consultations were made in the same way as for the costs of asthma attacks.

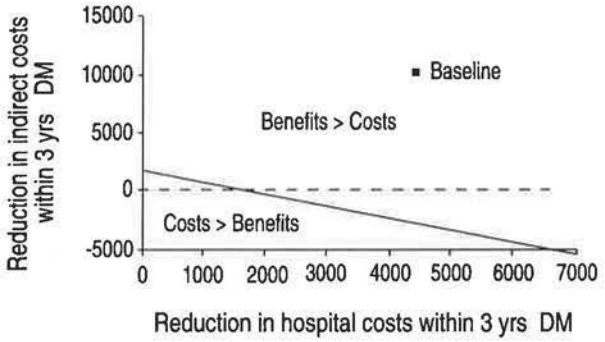

Fig. 1. – Plot of a two-way sensitivity analysis. The variables are the reduction in hospital costs and the reduction in indirect costs (lost productivity) per patient due to the intervention. (A negative reduction in indirect costs would be caused by an increase in sick leave days). The solid line indicates the co-ordinates for which the total costs are equal to the total benefits accumulated within 3 yrs after the intervention. Costs and benefits are discounted. For points below the line, the costs exceed the benefits. For points above the line, the benefits exceed the costs. This is the case with the values of the variables used in our analysis, indicated as "baseline".

Analysis

Costs were calculated for year one. In years two and three, there were no further programme costs. Savings were calculated separately for each year of follow-up. Net costs (negative costs=savings) in years two and three were discounted at a discount rate of 5% and added to the net costs of year one, to give the net costs (savings) for the programme within 3 yrs. Benefit/cost ratios were calculated by dividing the total (discounted) benefits within 3 yrs by the total costs.

Statistical significance of the reduction in hospital days, days of absence from work, asthma attacks and physician consultations was tested using the Wilcoxon signed-rank test. We compared the means of these variables in the 3 yrs after the intervention with their values in the year before the intervention. Drug consumption patterns

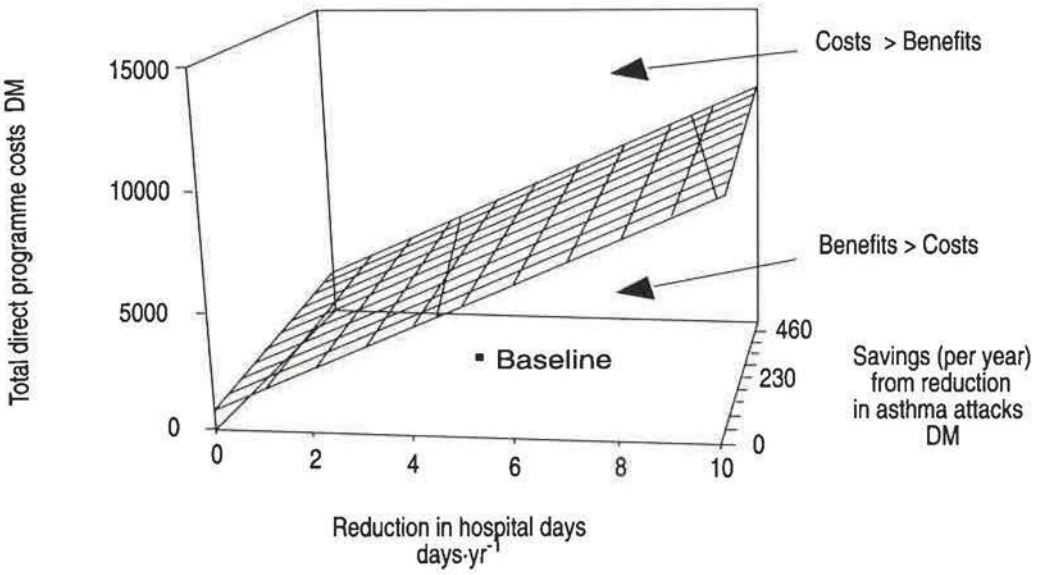

Fig. 2. – Plot of a three-way sensitivity analysis. The variables are the reduction in hospital days per year due to the intervention, the total direct programme costs, and the savings from the reduction in asthma attacks per year. The plane indicates the co-ordinates for which the total direct costs are equal to the total direct benefits accumulated within 3 yrs after intervention. For points above the plane, the costs exceed the benefits. For points below the plane, the benefits exceed the costs. This is the case with the values of the variables used in our analysis, indicated as "baseline" (total direct programme costs: DM 2,250; reduction in hospital days 5.2 days·yr^{-1}; savings from reduction in asthma attacks DM 230 per year).

were analysed by Friedman's test adjusted for ties. Two-tailed p-values of <0.05 were considered statistically significant.

Sensitivity analyses were performed on all of the key variables that might influence the result of the analysis due to uncertainty in their measurement. In one-way sensitivity analyses, we calculated the net costs within 3 yrs, varying the variable under study over a wide range of values. In two-way and three-way sensitivity analyses, by varying more than one variable at a time (figs 1 and 2), it can be determined, for any combination of values, whether they result in net costs or net benefits.

Results

Patient characteristics and use of resources

The patients' mean age was 40 yrs (range 16–75 yrs). The median duration of asthma was 12 (1–56) yrs. One hundred and thirty two patients (93 women and 39 men) completed the first year of follow-up. Seventy five (57%) of the patients were employed. Objective data on sick leave days were available for 41 patients. Sickness fund data on hospitalizations were available for 66 patients. (Patients are members of a large number of sickness funds. Some of them did not supply information on hospitalizations and sick leave days). Seventy eight percent of the patients were atopic. Mean FEV_1 %VC was 63% at initial assessment, 67% at follow-up after 1 yr (p=0.007), 69% after 2 yrs and 69% after 3 yrs. Mean FEV_1 was 2.3 *l* at initial assessment, 2.5 *l* at follow-up after 1 yr, 2.5 *l* after 2 yrs, and 2.39 *l* after 3 yrs (no statistically significant differences). Mean total airway resistance was 0.52 $kPa \cdot l^{-1} \cdot s$ at initial assessment, and 0.43 $kPa \cdot l^{-1} \cdot s$ at follow-up after 1 yr (p<0.01). The reductions in hospital days, days of absence from work, physician visits and acute severe asthma attacks are shown in table 1. The reductions in these variables were statistically significant. Data on drug consumption (maintenance therapy) are also shown.

Costs and benefits

Direct costs were those of the services delivered in hospital: staff, room and board, administration, food, heating, cleaning and other overhead costs. The *per diem* price per patient covering all of these costs at Düsseldorf University Hospital in 1991 was DM 378.70. It included DM 96.57 for room and board and overhead costs, DM 157.98 for nursery care, and DM 124.15 for medical care. Additional costs per patient included DM 43.50 for a peak flow meter, DM 37 for teaching material, and DM 289 for the nurse educator. The average *per diem* price of general hospitals (DM 327.02) was substantially lower than that of the programme at the University Hospital in Düsseldorf. (It is realistic to assume that hospitalizations other than that for the ATTP take place in general hospitals close to the patients' domiciles rather than in the more expensive University Hospital. Neglecting this difference could result in an overestimation of the savings). The average monthly gross salary, used for calculating indirect costs and benefits, was DM 4,251 [9].

The information about asthma attacks was available for 97 patients. The estimated treatment cost for an

Table 1. – Results of the asthma treatment and teaching programme (ATTP)

		After the ATTP				
	Year before the ATTP	Year 1	Year 2	Year 3	mean of years 1–3	p
Use of health care resources						
Hospital days * (n=66; 47)***	10.1	7.4	3.7	3.5	4.9	
Reduction in days		2.7	6.4	6.6	5.2	0.023
Days of absence from work * (n=41; 27)***	41.5	26.3	19.9	23.1	23.1	
Reduction in days		5.1	21.6	18.3	18.4	0.003
Physician visits ** (n=96; 93; 75)****	3.3	1.2	1.0	0.8	1.0	
Reduction in visits		2.1	2.3	2.5	2.3	<0.0001
Severe asthma attacks * (n=97; 75)***	4.8	1.1	1.0	1.0	1.0	
Reduction in attacks		3.8	3.9	3.9	3.8	<0.0001
Use of anti-asthmatic drugs						
Total number of substances ++	3.3	3.1	3.0	2.9	3.0	NS
Beta-agonists+ (MDI) (n=87; 82; 47)****	1.34	1.38	1.47	1.52	1.46	0.03
Theophylline+ (n=82; 73; 41)****	806	908	868	888	888	NS
Corticosteroids+ (MDI) (n=54; 56; 36)****	0.75	0.91	0.93	0.96	0.93	NS
Corticosteroids+ (systemic) (n=35; 36; 23)****	13	15	11	13	13	NS

*: per patient per year; **: per patient per month; ***: (years 1–2; year 3); ****: (year 1; 2; 3); +: average in $mg \cdot day^{-1}$; ++: per patient. MDI: metered dose inhaler; NS: nonsignificant; n: number of patients.

acute severe asthma attack was DM 62 (670 scores, monetary value of scores DM 0.093). The frequency of physician consultations could be obtained from 96 patients. The estimated average cost of a consultation was DM 11. The lump sum charged for visits to the out-patient service of the University Hospital's Pneumology Department was DM 31 per patient per year.

In the first year after the intervention, the costs of the ATTP were: direct programme costs (hospital) DM 2,250; indirect programme costs (lost productivity) DM 1,000. The benefits were: DM 800 reduction in hospital days; DM 2,950 reduction in days of absence from work; DM 250 reduction in physician visits; DM 200 reduction in asthma attacks. In the second and third year after the intervention no more costs occurred. The savings in year 2 were: DM 1,900 reduction in hospital days; DM 4,250 reduction in days of absence from work; DM 300 reduction in physician visits; DM 250 reduction in asthma attacks. The savings in year 3 were: DM 2,000 reduction in hospital days; DM 3,600 reduction in days of absence from work; DM 300 reduction in physician visits; DM 250 reduction in asthma attacks. As far as lost productivity is included, the results apply to an employed patient with average income.

This results in net benefits already in the first year when both direct and indirect costs and benefits are considered (net benefits of DM 950 in year 1, DM 6,350 in year 2, and DM 5,550 in year 3). As an alternative approach, the calculations were performed from the perspective of the paying bodies, *i.e.* without considering indirect costs and savings (lost productivity). In this case, the costs of the ATTP still outweighed the savings in year 1 (net costs DM 1,000). However, the savings already totalled more than half of the costs. There were net benefits in the second (DM 2,350) and in the third (DM 2,550) year. Already after year 2, the savings added from year 1 and year 2 by far outweighed the programme costs.

The overall result is shown in table 2. There are net benefits within 3 yrs, whether all costs and benefits or only direct costs and benefits are considered. For each German mark spent on the ATTP, society as a whole saved DM 5, the paying bodies saved DM 2.70.

Sensitivity analyses

One-way sensitivity analyses showed that there were always net savings within 3 years for any average salary (including zero), for any reduction in days of absence from work (including zero) and for any savings from reduction in asthma attacks and physician consultations (including zero). When only direct costs and benefits are considered, costs within 3 yrs would become positive if the average reduction in hospital days fell below 1 day per year or if the *per diem* price of hospitalizations fell below DM 150 (which is unrealistic). When indirect costs and benefits are included, there are net benefits within 3 yrs even without any reduction in hospital days, and at all levels of the *per diem* price, respectively. When the direct programme costs were varied, there were always net benefits within 3 yrs, up to direct programme costs of DM 6,000, which is far above the range of realistic assumptions (baseline DM 2,250). The results of a two-way and a three-way sensitivity analysis are shown in figures 1 and 2.

Table 2. – Costs and benefits of the ATTP per patient within 3 yrs

All costs and benefits	
Net benefits years 1–3*	12,850 DM
Benefit/cost ratio	5.0
Only direct costs and benefits	
Net benefits years 1–3*	5,900 DM
Benefit/cost ratio	2.7

*: discounted. ATTP: asthma treatment and teaching programme; DM: German marks.

Varying the salary in sensitivity analyses provided results for patients with different levels of income. When the salary is set to zero, the result is applicable to patients who are not employed. The result in this special case is identical with the analyses considering only direct costs and benefits. This may also be considered an analysis from the perspective of insurance companies paying for health care, for whom indirect costs are not relevant. Whether lost productivity is included or not, the overall result (net benefits within 3 yrs over a wide range of variation of all the key variables) remains the same. It is, therefore, not sensitive to the social and employment status of patients.

Discussion

This study has shown that the ATTP produced additional medical benefits (reduction in asthma attacks and improvement of pulmonary function tests) at lower costs than the standard treatment. The ATTP generated monetary net benefits within 2 yrs, due to the reduction in hospital days, days of absence from work, physician consultations, and acute severe asthma attacks. The same was true when indirect costs and benefits (lost productivity due to absence from work) were not included. The principal components of costs and benefits were days spent in hospital and days of absence from work, either for the programme or due to sequelae of asthma. This result is remarkable because, in most cases, interventions producing additional medical benefits cause additional monetary costs. It was obtained, despite making the most conservative estimates of the programme benefits.

In Germany, standard asthma treatment is delivered by office-based family physicians. At the time of the study, experts recommended a stepped care approach for moderate to severe asthma, using inhaled beta-agonists alone (first step), beta-agonists plus theophylline (second step), inhaled beta-agonists and corticosteroids plus theophylline (third step), and the third-step medication with additional oral corticosteroids (fourth step) [8]. Because drug consumption patterns did not change [7], drug costs were not included in this analysis.

Some limitations to this analysis have to be considered. The analysis was strictly limited to effects measurable in monetary terms. Improvements in quality-of-life,

however important to the patient, were not included in this formal analysis. It was also assumed that there is no influence of the ATTP on mortality. There is some uncertainty in the measurement of the parameters of effect. Determining some of the outcome variables (asthma attacks and physician visits) by questionnaire at follow-up examinations may introduce some inaccuracy, mainly underestimation of the events, due to imprecise recall. This is true, however, with events both before and after the intervention.

In the highly regulated health care sector, fees charged by physicians and hospitals are the result of negotiations between health care providers and insurance companies rather than of market mechanisms [12–15]. In cost-effectiveness analyses, these fees have to be taken as a proxy of "real" marginal costs. Therefore, the calculation of the direct costs reproduces primarily the perspective of the sickness funds (third party perspective), which may differ from the real costs to society. We used the average gross salary as an estimate of the loss in productivity. Whilst lost output can easily be measured in manufacturing jobs, this is more difficult in a white collar setting. Nevertheless, it should be a reasonable supposition that temporary absence from work leads to losses or delays in services provided [12, 13]. Whilst gross salary may overestimate losses in some instances, it should also be considered that there is probably some self-selection of patients in favour of participants with above average income. We did not try to give any precise evaluation of the lost productivity in patients who are not employed, such as housewives and students. It may be estimated at some point between the value for the average employee and zero, depending on the kind of activity concerned. For the remaining uncertainties in this point, it is particularly important to consider the results of the sensitivity analyses.

Another limitation is the before/after design of the study. The analysis rests on the assumption that the numbers of hospital days (after adjusting for the general decline in the duration of hospitalizations), days of absence from work due to sickness, physician consultations, and asthma attacks, in the patients studied would have remained the same as in the year before the programme, if the ATTP had not been performed. Theoretically, the decline in consumption of health care resources could be due to chance, to a time trend, or to other influencing factors. However, it is very unlikely that a statistically significant reduction in the outcome variables, which is stable over 3 yrs, should be due to such unknown factors. One would rather expect deterioration of these variables, with increasing age and duration of the disease. In addition, health statistics show that there was no general decline in sick leave days and physician consultations in the late 1980s in Germany. The percentage of sickness fund members on sick leave on particular days increased steadily from a minimum of 4.4% in 1983 to 5.2% in 1990, which is probably due to the favourable development of the economy in those years [10]. There was no general reduction in physician visits [16]. (Cost containment acts did not establish incentives for a decrease of this kind. while the number of physicians continued increasing). Moreover, it is noteworthy, that in Denmark teaching programmes on asthma with randomized designs have also shown similar results [5, 6]. In addition, sensitivity analyses showed that the overall result was quite stable over a reasonable range of variation of the key variables.

Given that there are still no data available on effects after more than 3 yrs of observation, only costs and benefits occurring within 3 yrs were considered in this study. Nevertheless, this analysis seems to be desirable, because the costs in connection with the initiation of the programme are a major obstacle to its widespread implementation. If the positive effects observed during 3 yrs could be demonstrated, as may be expected, over a longer period of time, this would be an additional reason for adopting the programme. The next step towards a more widespread implementation of the ATTP should be its translation to a limited number of hospitals, together with a proper evaluation of its effects. In this case, possible changes in drug consumption patterns, although they could not be demonstrated in the evaluation of this programme, might cause additional costs or benefits.

In summary, we conclude from the result of our analysis that, on the basis of the available data, from the viewpoint of both society as a whole and of the paying bodies, the ATTP should be implemented because of its economic and medical benefits. Long-term effects both on costs and benefits should become the object of further research.

Acknowledgement: The authors are indebted to support from the P. Klöckner-Stiftung, Duisburg, Germany.

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