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To cite this article: Alan Haycox, Gail Mitchell, Christie Niziol & Richard Featherstone (2002) Cost effectiveness of asthma treatment with a breath-actuated pressurised metered dose inhaler (BAI) - a prescribing claims study of 1856 patients using a traditional pressurised metered dose inhaler (MDI) or a breath-actuated device, *Journal of Medical Economics*, 5:1-4, 66-77, DOI: [10.3111/200505066077](https://doi.org/10.3111/200505066077)

To link to this article: <https://doi.org/10.3111/200505066077>



Published online: 02 Dec 2008.



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2002 Volume 5

Pages 65-77

**Cost effectiveness of asthma treatment with a
breath-actuated pressurised metered dose
inhaler (BAI) – a prescribing claims study of 1,856
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Cost effectiveness of asthma treatment with a breath-actuated pressurised metered dose inhaler (BAI) – a prescribing claims study of 1856 patients using a traditional pressurised metered dose inhaler (MDI) or a breath-actuated device

Alan Haycox PhD¹, Gail Mitchell MBA², Christie Niziol BSc RGN²,
Richard Featherstone MBA³

Summary

High levels of asthma resource use in the UK indicate that optimal control is not being achieved. This may be at least partly due to improper inhaler technique with metered dose inhalers (MDIs). One solution may be to prescribe inhalers that are easier to use, i.e. breath-actuated inhalers (BAIs). This analysis used a primary care database to assess the extent to which BAI (Easi-Breathe[®]*) patients differ from MDI patients in terms of their asthma related-resource costs. A child using the BAI had annual asthma medication costs that were £16.83 higher than a child using an MDI and an adult using the BAI had medication costs that were £3.02 higher. This was expected due to the higher unit cost of the salbutamol

BAI compared to the salbutamol MDI. However, a breakdown of medication costs showed that antibiotic and oral steroid costs were lower in the BAI group. The higher medication costs for BAI users were offset by the lower non-medication costs (£46.57 and £69.09 less for children and adults using the BAI, respectively). The result was a lower cost overall for BAI users compared to MDI users. Asthma is a therapeutic area which imposes a significant burden on both patients and health services. Given its increasing prevalence and morbidity levels, it is important to ensure that all possible steps are taken by clinicians to reduce this burden wherever possible. Such steps may include the prescription of BAIs.

Key words: cost-effectiveness, economic evaluation, asthma, breath-actuated, inhaler, Easi-Breathe[®]

Accepted for publication: 13 June 2002

¹ Department of Pharmacology, University of Liverpool, UK

² Abacus International, Bicester, UK

³ Ivax Pharmaceuticals UK Ltd, London, UK

Address for correspondence: Ms Christie Niziol, Abacus International, 3-4 Market Square, Bicester, Oxon OX26 6AA, UK. Tel: + 44 (0)1869 241281, fax: + 44 (0)1869 323248, e-mail: christie.niziol@abacusint.com

* Easi-Breathe[®] is a registered trademark of IVAX Pharmaceuticals UK Ltd.

Introduction

The UK has one of the highest prevalence rates of diagnosed asthma in international comparisons¹. The most recent audit reports that one in eight children and one in 12 adults are living with asthma in the UK, amounting to over 5 million people nationwide². A large proportion of these patients have disease that is inadequately controlled and consequently suffer debilitating daily symptoms and impaired quality of life².

Persisting asthma morbidity places a high burden on national primary and secondary healthcare systems. There are almost 4 million GP consultations for asthma each year in the UK and almost 75,000 admissions to hospital due to asthma² resulting in a total (indirect and direct) cost of approximately £2 billion annually³.

Of an average 330,000 patients managed by a typical primary care trust (PCT) 45,000 patients are likely to have diagnosed asthma. Each year these patients will account for over 400 emergency admissions, almost half of them will visit their GP at least once and eight will die from an asthma-related cause (three of these being under 65 years of age)². While little can be done regarding the high prevalence of asthma in the UK, it is apparent that there is substantial scope for improvement of asthma control.

The most obvious step towards improved asthma control is to optimise asthma therapy. Pharmacological asthma therapy centres around self-administration via

portable inhalers. Literature suggests that inhalation therapy may be less than optimal as a result of either patient characteristics (lack of compliance or poor inhaler technique) or inhaler characteristics (the inhaler mechanism fails to deliver adequate lung deposition of the drug)^{4–8}.

Currently, the most widely used inhalers in the UK and many countries are metered dose inhalers (MDIs). Technique with MDIs has been shown to be correct in only 21%–64%^{4,9,10} of patients and drug delivery to the lungs with a traditional MDI varies from 7%–20%¹¹. The major difficulties patients find with MDI use include poor co-ordination between breathing and firing and too fast an inspiration¹². While teaching has been shown to improve MDI technique^{10,13}, the benefit appears to be transitory¹⁰.

Among the most recent developments in inhalation devices are breath-actuated MDIs, also known as breath-actuated inhalers (BAIs). These have a similar appearance to traditional MDIs¹⁴ but being actuated by a slow inspiration do not require the press-and-breathe co-ordination needed for traditional MDI use¹⁴. In several studies patients and nurses have found BAIs easier to use, easier to teach and preferable to traditional MDIs^{11,14–19}. Studies report lower error rates with BAIs compared to traditional MDIs¹⁷ and that BAI users often have better inhaler technique^{17,20,21}. If these results can be translated into improved asthma control and decreased resource use, BAIs may have potential for significantly reducing the economic burden of asthma

and contributing to improved control/morbidity.

Published studies conducted in the USA report that the healthcare costs of patients using breath-actuated inhalers are between 16% and 23% less than those using MDIs^{22,23}, the key factors being inpatient, emergency outpatient and relief medication costs. It is also reported that patients using breath-actuated devices had 50% less days off school or work due to asthma, thus reducing the indirect costs of asthma²³.

This study investigated whether the apparent advantages of a BAI (Easi-Breathe[®]) over a traditional MDI translate into less healthcare costs and greater cost effectiveness, in line with published data from the USA.

Methods

This retrospective, cost-consequence analysis set out to quantify and compare the healthcare costs of existing asthma patients who were switched from their existing MDI to either a BAI or a different MDI.

Data sources

Clinical data

To obtain data on the amount of rescue and relief medication used and respiratory-related primary and secondary care resource use, this study utilised an electronic UK primary care database

[Doctors Independent Network (DIN-LINK)].

DIN-LINK database

The DIN-LINK database contains in-depth medical information from a representative sample of approximately 210 GP practices in Great Britain. This medical information is screened to allow analysis of only the most accurate and complete data (amounting to 100 practices for this particular analysis). Practices are geographically spread and comprise a range of sizes²⁴. In total, approximately 380 GPs and almost 900,000 patients are represented by the database. DIN-LINK has been used previously in similar published reviews of prescribing practices in the UK²⁵.

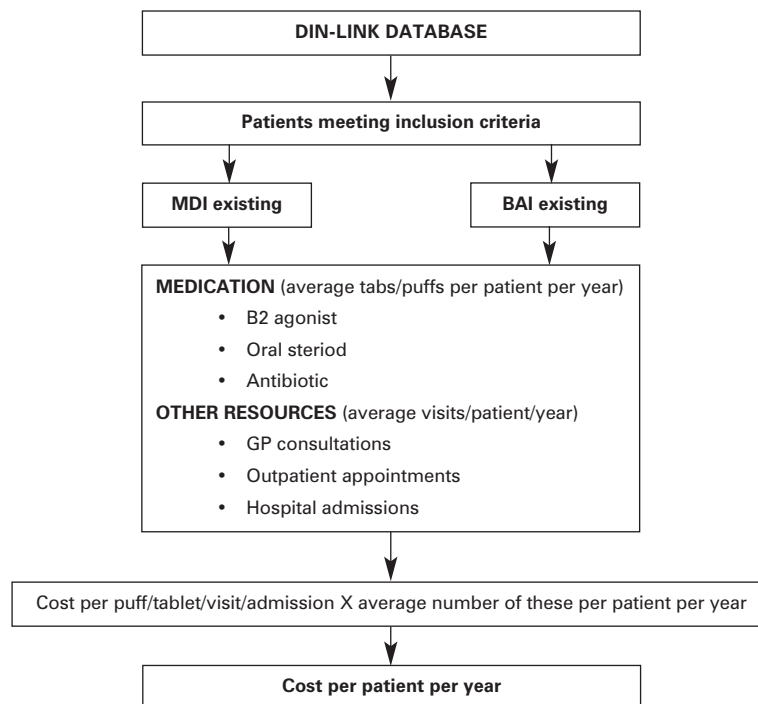
DIN-LINK is limited to GP practices using the AAH Meditel computer system and the data obtained is dependent on the completeness of the information entered. This means that numbers for hospital admissions and outpatient appointments may be under-reported.

Patients

All patients with a diagnosis of asthma attending one of the 100 DIN-LINK GP practices in the UK were eligible for inclusion in the study if they met the following criteria:

- 1 Had their inhaled corticosteroid (ICS) therapy changed (a) to a BAI from an existing MDI or (b) to a new MDI from an existing MDI, during the 21 months from July 1998 to March 2000.

Figure 1. Study design



¹Solely used either the same MDI or BAI for all ICS medication for a full 12-month period in order to avoid contamination of outcomes for patients receiving more than one device.

¹Received only the Easi-Breathe[®] BAI for ICS therapy to avoid distortion by the differing attributes of individual BAIs.

Medical records of patients meeting the inclusion criteria were analysed to identify the asthma-related medication and other clinical resources used by patients over a period of 12 months (i.e. 12 months from the date of their change in ICS inhaler). A cost was applied to each medication or resource; this was used to quantify the asthma healthcare costs of patients in the MDI versus BAI cohorts (Table 1).

Table 1. Cohort definitions

Group	Description
BAI	Existing Patients who were switched from an existing MDI to the Easi-Breathe [®] BAI for their inhaled steroid asthma treatment, remaining on the BAI throughout the study period.
MDI	Existing Patients who were switched from an existing MDI to a different MDI for their inhaled steroid asthma treatment, remaining on the new MDI throughout the study period.

The results were further categorised into children (0-12 years) and adults (13+ years).

Table 2. Weighted cost per puff (pence sterling) for inhaled medication

	<i>Beclomethasone</i>				<i>Salbutamol</i>
	<i>50 µg</i>	<i>100 µg</i>	<i>200 µg</i>	<i>250 µg</i>	<i>100 µg</i>
Cost per puff					
MDI	2.17	4.12	7.84	9.01	0.98
BAI	2.17	4.12	N/A	9.01	3.15
Proportion of usage					
MDI	7%	33%	16%	44%	100%
BAI	11%	60%	N/A	29%	100%
Weighted cost per puff					
	<i>Beclomethasone</i>				<i>Salbutamol</i>
MDI	6.75				0.98
BAI	5.77				3.15

Cohort comparability

Socio-economic status was examined using the ACORN (A Classification Of Residential Neighbourhoods) socio-economic groups²⁶. Average age and gender split were compared between the traditional MDI and BAI cohorts to confirm demographic comparability.

exacerbations as their usage is recommended in acute exacerbations⁸.

Patients with uncontrolled asthma are more prone to being diagnosed with respiratory infections^{28–30}, therefore antibiotic usage provides useful additional information about asthma control.

Outline of analysis

Figure 1 outlines the study design for this analysis.

Prescribing outcomes

Medication information was reported in mean number of puffs/dose units, per patient, per study period (12 months). The following medication has been included in the study.

Short acting β_2 agonist usage: this has been used and recommended as a measure of asthma control in guidelines⁸ as well as in other studies²⁷.

Inhaled steroid, included as the standard preventative therapy for asthma⁸.

Oral steroid courses were included as real-life markers of significant asthma

Other resource use outcomes

The frequency with which a patient needs to see their GP for asthma-related symptoms or respiratory infections is considered a good indicator of asthma control³¹. Likewise the frequency of requiring referral for outpatient appointments or hospital admissions for asthma is likely to correlate with the degree of control the patient is experiencing³¹. These resources have been analysed and are reported as the mean number of consultations/visits/admissions per patient per year.

It was originally intended that numbers of emergency admissions would be compared between the treatment groups. However the number of these reported was too small to be meaningful. This may have been due to underreporting in the database.

Cost data

Information on the proportionate use of the various strengths of MDI and BAI inhaler were obtained from the DIN-LINK database. This allowed a weighted cost per puff to be calculated based on proportionate use (Table 2). Patients were grouped according to the device used for ICS therapy. An assumption has been made that patients prescribed at BAI ICS are also likely to be prescribed their B₂ agonist via a BAI. Based on this assumption, the unit cost of the BAI B₂ agonist was used for patients in the BAI group. If any bias has occurred here it is likely to be against BAIs as the B₂ agonist BAI is more expensive than the B₂ agonist MDI. Medication costs for branded drugs were obtained from the *Monthly Index of Medical Specialities* (MIMS)³² (Table 3). Medication costs for generic drugs were obtained from the *British National Formulary* (BNF)³³. All resource costs were obtained from the Personal Social Services Research Unit (PSSRU)³⁴ (Table 4). Patients were assumed to stay in hospital for an average of 4.9 inpatient days per admission based on evidence from the literature³⁵.

Statistical analysis

Statistical analyses were performed using SPSS (statistical package social services) version 10.1. Subgroup comparisons were produced by the use of analysis of variance (ANOVA) and the Student's t-test (two group comparisons). A *p*-value of <0.05

Table 4. Resource costs³⁴

Cost	
GP consultations	£19.00
Outpatient appointments	£88.00
Hospital admissions per day	£246.00
Hospital admission total (i.e. x 4.9 days)	£1205.40

was considered significant. In addition, 95% confidence intervals are provided for continuous variables.

Results

This study included 1,856 existing asthma patients, 1,481 of whom used an MDI for the study duration and 375 used a BAI. This difference in patient numbers reflects real life practice (i.e. currently MDI is the most widely used inhaler). Despite differing patient numbers the groups are similar with respect to demographics (Table 5). The relationship between gender, age and asthma prevalence in the present study agrees with literature on UK asthma prevalence³⁶.

The BAI and MDI cohorts are similar with regard to socio-economic status (ACORN scores)²⁶ (Figure 2). In the MDI group, 332 of the patients were under 13 years of age (children) and 1149 were adults. In the BAI group 60 patients were children and 315 were adults.

Table 3. Other medication costs³³

	Cost per pack	Tablets per pack	Cost per tablet
Oral steroids (prednisolone 5 mg)	67p	28	2.39p
Oral antibiotics (amoxicillin 250 mg)	£1.18	20	5.9p

Table 5. Patient demography

<i>Subgroup</i>	<i>No.</i>	<i>Males No. (%)</i>	<i>Females No (%)</i>	<i>Average age (years)</i>	<i>Range (SEM)</i>
Children (0-12 years)					
MDI	332	200(60%)	132(40%)	7.02	0.05
BAI	60	34(57%)	26(43%)	8.93	0.58
Adults (13+ years)					
MDI	1149	469(41%)	680(59%)	44.38	0.57
BAI	315	124(39%)	191(61%)	44.29	2.5

Medication costs

Table 6 presents the medication costs for MDI versus BAI in children and adults. As would be expected (due to the higher unit cost of the β_2 agonist BAI compared to the β_2 agonist MDI) the total cost of asthma drugs in the BAI group was higher than the MDI group. However, the use of additional related medication was substantially lower in the BAI patients. The cost of prescribing oral steroids was 67% less in children using the BAI and 73% less in adults using a BAI than in the MDI patient groups. The cost of prescribing antibiotics was 76% less in children using the BAI and 56% less in

adults using the BAI.

Resource costs

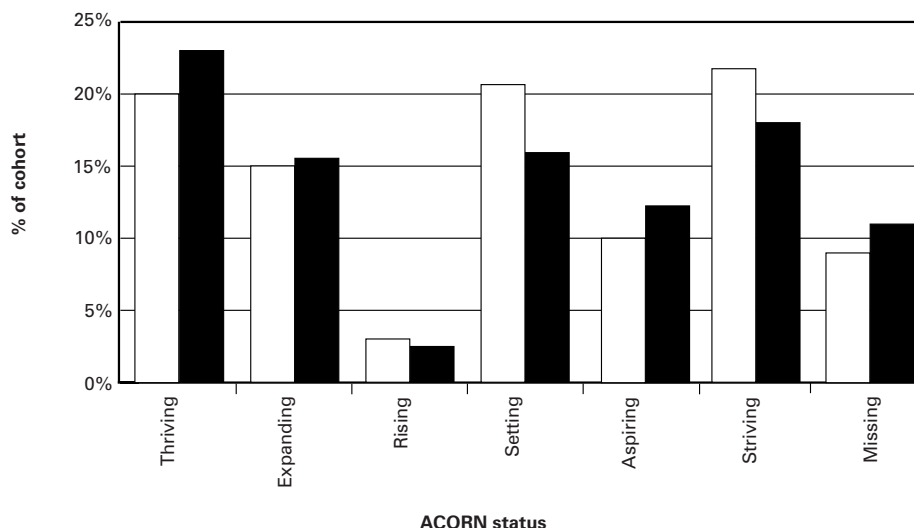
Table 7 presents the (non-medication) resource costs of MDI versus BAI patients. The non-medication resource use costs of children and adults using the BAI were less than those of patients in the MDI groups. This was observable in all measures of resource use. Overall, a child using the BAI had non-drug resource costs, which were £46.57 less than a child using an MDI, likewise an adult using the BAI had non-drug resource costs which were £69.09 less than adults using an MDI.

Table 6. Medication costs per patient, per year for BAI users compared to MDI users (children and adults)

<i>Prescription</i>	<i>Children (0-12 year olds) (n=392)</i>					<i>Adults (13+ year olds) (n=1464)</i>				
	<i>MDI n=332</i>	<i>BAI n=60</i>	<i>Difference</i>	<i>%</i>	<i>p</i>	<i>MDI n=1149</i>	<i>BAI n=315</i>	<i>Difference</i>	<i>%</i>	<i>p</i>
Inhaled steroid prescriptions	£53.66	£51.03	-£2.63	-4.9	$p=0.985$	£68.80	£56.83	-£11.97	-17.4	$p<0.05$
β_2 agonist prescriptions	£8.82	£28.80	+£19.97	+226.3	$p<0.05$	£13.52	£29.75	+£16.23	+120.1	$p<0.05$
Oral steroid prescriptions	£0.24	£0.08	-£0.16	-66.9	$p<0.05$	£1.03	£0.28	-£0.75	-72.9	$p<0.05$
Antibiotic prescriptions	£0.46	£0.11	-£0.35	-76.4	$p<0.05$	£0.89	£0.40	-£0.49	-55.5	$p<0.05$
Total	£63.19	£80.01	+£16.83	+26.6	$p=0.04$	£84.23	£87.25	+£3.02	+3.6	$p<0.709$

–, less cost with BAI; +, more cost with BAI.

Figure 2. Socio-economic status (ACORN scores)²⁶. n, MDI; n, BAI



Total (per person) health costs

Table 8 presents the total health care costs (medication costs plus other resource use costs) for MDI users compared to BAI users (children and adults).

Overall, total costs for a child using the BAI were an average of £29.74 less per year than for a child using an MDI, and total costs for an adult using the BAI were £66.06 less per year than for an adult using an MDI.

Distribution of costs

Figure 3 shows the percentage distribution of NHS costs for BAI patients and to MDI patients. As expected (due to the higher unit cost of the salbutamol BAI) a larger proportion of the total cost for BAI patients relates to medication (60% (£83.91)) compared to MDI patients (39% (£77.89)). However, the total average cost for a patient using the BAI was £55.69 less per year than for a patient using an MDI. This

mostly reflects the fact that there were fewer non-medication resource costs for BAI patients (£55.91 versus £117.62).

When the non-medication resource cost is separated into its constituent elements, it can be seen that with BAI patients a lower proportion of these costs are spent on the more expensive items such as hospital admissions (7% (£9.64)) and outpatient appointments (3% (£4.22)) compared to MDI patients (hospital admissions 17% (£32.55), outpatient appointments (11% (£20.68)).

PCT costs

A typical PCT of 330,000 patients is likely to have around 45,000 patients with asthma². If a PCT treated all its asthma patients with an MDI the total asthma-related healthcare cost (based on the total per person costs demonstrated above) would be almost £8.8 million. However, if the PCT treated all its asthma patients with the BAI the cost would be £6.3 million. If

Table 7. Resource costs per patient, per year for BAI users compared to MDI users (children and adults)

Prescription	Children (0-12 year olds) (n=392)					Adults (13+ year olds) (n=1464)				
	MDI n=332	BAI n=60	Difference	%	p	MDI n=1149	BAI n=315	Difference	%	p
GP consultation	£50.65	£26.28	-£24.36	-48.1	p=<0.05	£68.38	£45.06	-£23.33	-34.1	p=<0.05
Outpatient attendance	£7.69	£0	-£7.69	-100	p=0.003	£24.51	£5.03	-£19.48	-79.5	p=<0.05
Hospital admissions	£14.52	£0	-£14.52	-100	p=0.591	£37.77	£11.48	-£26.29	-69.6	p=0.073
Total	£72.86	£26.28	-£46.57	-63.9	p<0.05	£130.65	£61.57	-£69.09	-52.9	p<0.05

–, less cost with BAI; +, more cost with BAI.

patients currently on an MDI are interchangeable with those on the BAI, this demonstrates a potential saving of £2.5 million if the BAI is chosen. The largest difference in costs seen with BAI use compared to MDI use is in non-medication resources. An average of 1.18 fewer GP consultations per person per year were required by BAI patients (adults and children combined) compared to MDI patients. This equates to 37,170 fewer asthma-related GP consultations for a PCT if all patients currently treated with an MDI are switched to a BAI (based on the fact that 70% of all asthma patients use an MDI³⁷). This reduction demonstrates a cost saving of £706,230 per year for GP consultations alone.

Discussion

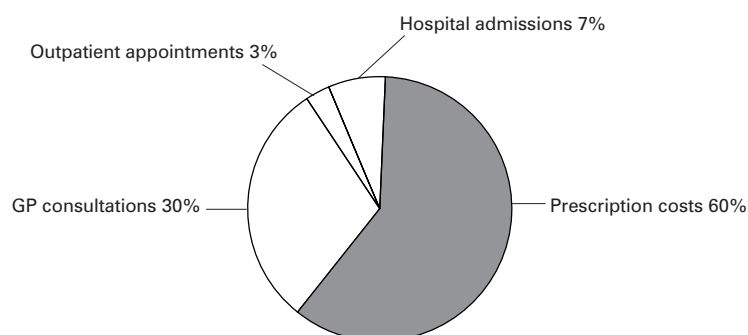
The selection of an optimal inhaler device is dependent upon several factors such as the therapeutic effect, ease of use, cost and patient acceptability. Any move away from the current clinical status quo in which the majority of patients use MDIs must result from clear and incontrovertible evidence concerning the clinical and economic benefits that would arise as a consequence of such a shift.

Traditionally, such evidence has been generated through properly conducted trials employing relevant clinical end-points. Unfortunately few such high quality trials have been undertaken in this area and the clinician will have considerable difficulty in identifying robust and reliable evidence to inform their choice between BAIs and MDIs. There is an

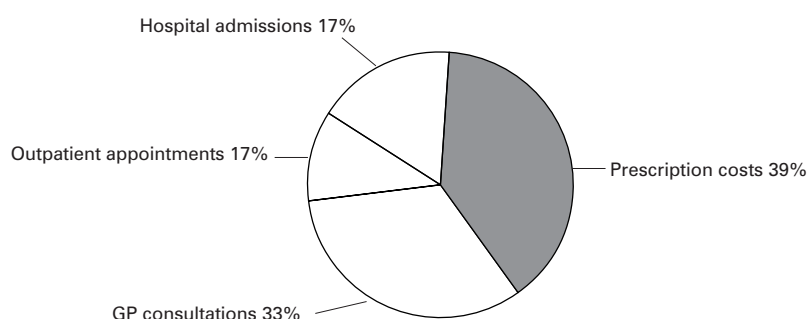
Table 8. Total asthma health costs per patient, per year for BAI users compared to MDI users

Age group	MDI	BAI	Difference	% Difference	p
Children	£136.04	£106.30	-£29.74	-21.9	p=0.360
Adults	£214.88	£148.82	-£66.06	-30.7	p<0.05

Figure 3. Distribution of NHS costs. n, non-medication resource costs; p, prescription costs



BAI cost distribution (average annual cost = £139.82)



MDI cost distribution (average annual cost = £195.51)

urgent need therefore to extend the evidence base available to clinicians concerning the comparative clinical and cost-effectiveness of these two forms of inhalers.

This analysis has employed a valuable alternative approach to generating such evidence by analysing a large scale medical database to obtain evidence on the comparative cost-effectiveness of the Easi-Breathe[®] BAI and MDIs in asthma treatment. One major advantage of this

approach is its focus on resource use derived from real world data. In addition, because of the size of the database analysis undertaken and the variety of GP practices covered, the sample is representative of the treatment of asthma patients by the NHS. The restriction of this analysis to treatment provisions prescribed in primary care avoids distortion of results by patients who are exceptionally ill or going through an exceptionally bad control phase of their asthma, requiring prescriptions from a secondary care source.

Having emphasised the strengths of observational database analyses, it is equally important to highlight areas of potential weakness. Most of the weaknesses result from the non-randomised and retrospective nature of such analyses. This can result in comparisons that appear unusual to clinicians versed in the highly controlled and constrained environment of randomised controlled trials (RCTs). For example, the comparison groups may appear to be unbalanced (1481 patients on MDI and only 375 on BAI). However, such proportions reflect the comparative usage of the different types of inhaler in current treatment patterns. In the absence of randomisation, the quality of any database analysis is intrinsically linked to the extent to which the cohorts being analysed have been matched to ensure similarity in all respects other than the variable of interest (use of MDIs and BAIs). Such matching is vital to ensure that other unrelated differences have not led one group to be comparatively high utilisers of healthcare resources. In this case, the matching process found that patients were in general similar in terms of their age, gender and socio-economic status.

Large-scale database analyses of this nature provide useful information, which can raise issues that can then be addressed in greater detail by high quality studies. For example, the extent to which the apparent benefits associated with BAIs can be generalised with regard to the nature and severity of the asthma suffered is one crucial area for further research. While the results obtained from this analysis are best

interpreted as being largely exploratory, the extent and persistence of the resource savings identified for patients using BAIs would appear to be highly persuasive. Other studies have considered the use of these inhalers in new asthma patients and have found similar outcomes³⁸.

NHS costs account for less than half (38%) of total asthma-related costs, with the department of social security absorbing 7% of the total cost and lost productivity accounting for the remaining 55%². The prescribing and resource costs for the BAI cohort in this study represent less resource use and less need for medication than traditional MDI patients. Patients on the BAI therefore appear to have asthma that is better controlled with fewer exacerbations and they are inferably less likely to require time off work. Thus lost productivity and social security costs are also likely to be less for patients using the BAI compared to patients using an MDI.

An area of interesting further research would take into account the use of long acting B₂ agonists and other drugs indicative of more severe asthma.

In conclusion, we have demonstrated that treatment of asthma patients with the Easi-Breathe[®] BAI appears to be associated with a significant reduction of healthcare resource use. The results emphasise the potential value of switching patients in appropriate cases from MDIs to BAIs in an attempt to reduce the resource burdens associated with asthma.

Acknowledgement

Financial support for this study was provided by a grant from IVAX Pharmaceuticals Ltd.

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